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Editorial Notes

Activated Cokes

We continue in our issue to-day publication of further contributions to the symposium on the production and utilization of domestic coke at the joint meeting on Nov. 18 of the North-Western Section of the Institute of Fuel and the Manchester District Association of Gas Engineers. Three of the short Papers relate to alkali activation of cokes, and are of particular interest. It is ten years since we published in the "JOURNAL" the results of work at Leeds University on the addition of sodium carbonate to a high-temperature coke. This work, which was undertaken by Miss Margaret Bligh and Mr. H. J. Hodsman, showed that the addition of sodium carbonate increased the rate of combustion in an open grate and enabled a more pleasing and a more flexible fire to be obtained. This, as was pointed out by Mr. P. J. Askey at the meeting to which we have referred, is only one example of the activating effect of alkalis on fuels which has been investigated by Prof. Cobb and his collaborators. Since that time the alkali process for the activation of fuels has received little attention from the Gas Industry, in spite of the obvious desirability of manufacturing reactive solid smokeless fuels. This has been due to fear of alkali attack on the refractories of retorts and to the cost of the sodium carbonate necessary to give the activating effect.

Mr. Askey reports the results of investigations into this question of alkali activation carried out recently by Imperial Chemical Industries. It has been found that in ordinary coke containing from 5 to 10% of ash the acidic constituents of the ash combined with the sodium carbonate added, and consequently a considerable portion of the sodium carbonate was put out of action as far as any activating effect was concerned. It has also been shown that if a mixture of lime and sodium carbonate was added before carbonization the lime combined preferentially with these acidic constituents, leaving the sodium carbonate free to activate the coke. It was possible to obtain the maximum activity using lime *plus* 0·5 to 1% of sodium carbonate. Moreover, less lime than sodium carbonate is needed to neutralize the acidic constituents, and therefore the total addition of lime and sodium carbonate is less than sodium carbonate alone. Again, lime is much cheaper than sodium carbonate, and the possibility of alkali attack on the refractories of carbonizing plant is reduced. These considerations should make a great deal of difference to both the economic and the practical application of alkali activation.

Estimated Costs

As far as the I.C.I. investigation has gone the conclusion is drawn that with the more reactive coals it should be possible by alkali activation to make reactive cokes in vertical or horizontal retorts, and "possibly even in coke ovens," under normal carbonizing conditions provided the coke is not over-coked. With less reactive coals alkali activation in vertical retorts should give the required reactive coke under normal conditions, but in horizontal retorts and in coke ovens some additional means of increasing reactivity will probably be necessary. The two obvious methods are under-carbonizing and blending. The production of cleaner coals will, of course, materially assist the application of alkali activation, for the process inevitably increases the ash content of a coke. To produce a coke of not more than 6% of ash, it is necessary, where alkali activation is used, to start with a coal of not more than 3% of ash. Mr. Askey discusses the likely cost of the process. Assuming that 0·5% of sodium carbonate and 1% of lime on the coal are necessary, the cost should be about 1s. 3d. per ton of coal, or about 1s. 8d. per ton of coke. If 1% of sodium carbonate is necessary, the cost will be about 2s. to 2s. 5d. per ton of coke. If clean coal is used, the cost of cleaning will be offset by the decrease in the lime required.

The Midland Coke Research Committee has investigated on a semi-large scale the laboratory tests made by Imperial Chemical Industries, and the results were reported at the meeting by Dr. R. A. Mott. Two series of tests were made, one with a washed slack containing 7% of ash, the other with coal from the same source cleaned to 2% of ash. These tests have shown it possible to manufacture in a coke oven, by alkali addition and under-carbonization, an open grate

coke which could be ignited as easily as coal. This was when the charge was under-coked by 4½ hours. If one under-carbonizes less drastically, a fuel is obtained which, "while requiring a more powerful ignition, is flexible in use and gives a pleasant fire." Dr. Mott concludes: "Although further tests are required in confirmation, it may prove the most satisfactory to the coke maker to use 0·5, 0·75, or 1·0% of sodium carbonate with low ash coal which would require addition of about 0·5% of hydrated lime, and to under-carbonize for about 1½ hours."

Work at Liverpool

THE information given by Dr. Mott was supplemented at the meeting by Mr. H. H. Thomas, who explained what is being done by the Liverpool Gas Company on this fascinating problem. Experiments have been conducted at Liverpool on both a horizontal test plant and on normal vertical coals in large-scale vertical retorts, the most consistent results from activation having been obtained in the vertical plant. In any case, "the results obtained are most encouraging, and there is no doubt that the method can be used to increase the production of free-burning domestic fuel with the high-temperature carbonizing processes used by the Gas Industry." As Mr. Thomas says, the question of the effect of the added alkali on the refractory will have to be determined by experiments over a period of at least twelve months; and as a matter of fact this is being done. Apparatus has been installed on a vertical retort which enables alkali to be added in proportion to the flow of coal. The retort will then be compared with others working under similar conditions without alkali addition. It may be that sodium carbonate has little effect upon the refractory. Mr. Askey puts forward the view that the effect on the life of refractories will not prove as serious as some people suggest. He goes on to say that since the introduction of high silica refractories the danger due to salt in coals has become negligible and that there is no evidence that alkali should be more dangerous than salt. On the contrary, there is reason to believe that it should be less dangerous. In this connection we would refer again to the article by Mr. H. T. S. Swallow, also of the Research Department of Imperial Chemical Industries, which was published in the "JOURNAL" for Nov. 11 last. In this he observed: "There is no reason to suppose that the action of the alkali would even be more than one of the minor causes of the ultimate failure of the refractories, or that it would result in noticeable increases in working costs." If as a result of long-term experiment fears in this regard prove to be unfounded, alkali activation, in some cases alone, in others in conjunction with other methods of increasing the reactivity of coke, may provide a solution of the problem of preparing a satisfactory free-burning coke by carbonization in gas retorts or coke ovens. Results of the experiments at present being conducted will be awaited with the keenest interest.

Fuel Research

CONCERNING research in our Industry, we regard with the liveliest satisfaction the increasing co-operation with other research organizations, and in particular with the Fuel Research Board. Reference to this closer liaison was mentioned in the 2nd Report of the Research Executive Committee of The Institution of Gas Engineers presented at the Autumn Research Meeting last month. The Joint Research Committee of the Institution and Leeds University is, quite rightly, giving close attention to possible methods of gas manufacture which may form alternatives to present methods of carbonization and give to the Industry a greater freedom in determining the relative yields of primary and secondary products. In itself, complete gasification of coal offers no difficulties; the problem which is being investigated is the production by complete gasification of gas of a quality suitable for distribution as town gas, and the necessary enrichment of complete gasification can be effected by methane synthesis under high pressures. The field is a wide one, and wisely the Committee sought the assistance of the Fuel Research Board. Now we have a Joint Committee on Complete Gasification, under the Chairmanship of Mr. E. V. Evans and consisting of representatives of the Joint Committee of the Institution and Leeds University and of the Fuel Research Division of the D.S.I.R. We feel that a great deal will come from the investigations in being and to be carried out; the planning of these investigations is unquestionably on the right lines.

As another example of co-operation between our Industry and the Fuel Research Board we may recall the work on the carbonization of cannel carried out jointly by the Edinburgh Gas Department and the Board, the results of which were given in the Paper by Mr. Jamieson and Dr. King at the Annual Meeting of The Institution of Gas Engineers last June. The investigation has benefited, and will benefit, Edinburgh gas consumers, and the results have importance and significance nationally as well as to the Gas Industry itself. Reference to this work is made in the Report of the Director of Fuel Research for the year ended March 31, 1936, which, together with the Report of the Board, was published last week. The Report is obtainable from H.M. Stationery Office (4s., postage extra). The close relationship between many of the problems which are being studied at the Fuel Research Station and those which are being tackled by our Industry is apparent from the Report, which will be widely read by those connected with the carbonizing industries. It is remarked in the Report that the promising results of the investigation of carbonizing Newbattle cannel at Edinburgh suggest that an early study of other cannel is desirable in order to determine how far the high yields obtained at Edinburgh could be realized by gas undertakings in other districts.

Effect of Storage on Coal

REFERENCE is made in the Report to another investigation which is being undertaken at Edinburgh. For more than two years experimental consignments of a score of Scottish coals have been standing at the Granton Works of the Edinburgh Gas Department, where they have been examined at intervals by analytical and carbonization tests. It is anticipated that observations will extend over another two years. The Report states: "As the mass of numerical data being collected meanwhile must be studied largely from a statistical standpoint, it is as yet unsafe to say definitely what the precise effect of storage is on all the properties examined; in fact, the results available hitherto show clearly how difficult it is in this class of work to arrive at a quanti-

tative estimate of the effect of time on any particular property. A decrease in coking power and in the yield of gaseous therms on carbonization, and marked disintegration of all coals except cannels, have been recorded. There is nothing new in these observations, but there is a possibility of giving in the long run quantitative expression to the amount of change which occurs in a given time." Observations of a similar nature are being maintained by the Birmingham Survey Laboratory on experimental stacks of coal in the Forest of Dean, and a similar investigation is being arranged at the Fuel Research Station.

Work has been continued on the steaming of the charge in horizontal retorts. The setting at the Station was overhauled and repaired in July of 1935, since when the retorts have been employed mainly to assess the increase in yields of gas with steam supplied during the last two and the last three hours of the carbonization period of 12 hours with charges of 12 cwt. of coal. Particular attention has been paid to the amount of steam decomposed. In regard to steaming the charge for the last hour of the carbonization period, it was found that a rate of 20 lb. per ton gave the highest figure for steam decomposition, and about 130 lb. per ton appears to be the upper practical limit. Higher rates of steam supply gave higher thermal yields of gas, but also resulted in high pressures during the first part of the steaming period, with consequent excessive losses, and, in addition, they caused trouble with choking of offtake pipes. Introducing steam to a total of 20 lb. per ton of coal over the last two hours gave slightly better results than when the same total quantity of steam was introduced in the last hour. When, however, 20 lb. of steam per ton of coal was introduced during each of the last two hours, the thermal yield was slightly less.

Work on Blending

Considerable attention has been paid during the year to the question of the mixing or blending of coal from different seams. There are already signs, the Report states, of a shortage in first-class coking smalls in the country, and it has been recognized that the supply of the finest coking coals is limited, although there is no lack of coal possessing medium coking properties. Increased knowledge of the possibility of blending coals which, although unsuitable for use alone, will yield satisfactory coke when blended, is of major importance. Another advantage of blending is the possibility of confining within strict limits the proportion of sulphur or phosphorus in metallurgical coke. The setting of narrow brick retorts, designed at the Station, which during the last 4½ years has been undergoing an endurance test, shows little deterioration, and a setting to this design has been erected by the South Yorkshire Chemical Works, Ltd., at Rotherham. At the request of the War Office, an investigation has been made at the Station with the object of producing active carbon for gas masks from British coal. Successful results have been achieved after very little special work. It has been found that certain hard coals (durain) with a suitable but rather critical degree of caking power, if carbonized in suitable sizes at low temperatures, and then activated by steam at high temperatures, will provide an active carbon—very nearly, if not quite, as good as the best obtainable from other sources, and at a considerably lower cost.

In connection with the conversion of tar into motor spirit and fuel oils the Report states that the semi-commercial scale plant erected by the Fuel Research Station designed for the treatment of 200 to 400 gallons of raw material a day has worked satisfactorily during the year. This plant was erected with two objects in view. The first of these was to work out a technique and method of operation applicable to a large scale plant. The second entailed the examination of the effect of variables such as temperature, pressure, &c., to correlate the results obtained with those from small scale laboratory plants and ultimately to determine the best working conditions for various raw materials. The first objective has now been accomplished. The engineering difficulties and those of temperature control, the Board state, have been overcome, and experience has been gained which would enable a simple large scale plant to be designed if required. Work is now in progress on the second objective, but before optimum conditions can be established the great difficulty associated with the rapid deterioration of the catalyst must be overcome. The molybdenum sulphide now used as a catalyst has a life of 4 to 6 weeks, and this is insufficient for large scale practice. Further experience has been gained in the technique of the Fischer process for the production of hydrocarbons from water gas. Small samples of lubricating oil fractions have been produced from the primary products by treatment with anhydrous aluminium chloride; and on the basis of the experience gained with the laboratory-scale apparatus it has been decided to construct a plant of sufficient capacity to give one litre of lubricating oil per day. Another line of attack is being developed in the transformation of water gas into lubricating oils, with alcohol as an intermediate product.

A Debate on Electricity

On Wednesday last week the House of Commons discussed the affairs of the electricity industry. The matter arose on a Socialist Motion advocating "that there should be established a national electricity authority responsible for securing the efficient direction and management of the industry." The debate occupied the time of the House from 3.53 until 7.30 and, having perused the speeches with some care, it is difficult for us to disagree with the comment of the Minister of Transport that "we might have spent the afternoon in an even more pleasant way than we have." As might be expected, opposition members utilized the Motion to extol the excellence of theoretical socialism; the Motion was framed—as Mr. Hore-Belisha said in a flowery phrase—"in such a way as to light incense on the altar of a theory without regard to practical considerations."

Underlying this superstructure, however, there was apparent on both sides of the House a genuine apprehension as to the intentions of the Government with regard to the McGowan Report. This apprehension had not been lessened by the reply of the Prime Minister to a question with regard to the matter on Nov. 9. In this reply Mr. Baldwin referred to the full programme of legislation already promised, and stated that he could not undertake that at the present it would be possible to add to it. He gave an assurance, however, that the Government were alive to the importance of the McGowan recommendations, and had the matter closely before them.

If members expected that the debate of last Wed-

nesday would elicit from the Government a more ample statement of their electrical policy, they were disappointed. The debate, however, was not without interest. It was made clear that the Socialist support which the Conservative Government of 1926 were able to secure for their Bill inaugurating the Grid System will not be so readily forthcoming in respect of any legislation designed to implement the findings of the McGowan Report. It is also apparent that the Government are by no means convinced that the centralization applied to generation and main transmission could with equal success be applied to distribution. "Distribution," said the Minister, "is mainly salesmanship, and complete centralization of distribution will not necessarily produce the best conditions for local buyers." He agreed with the McGowan Committee in their rejection of stereotyped national or regional boards, which might dislocate an established and expanding industry.

With regard to generation all was, according to the Minister, for the best in the best of all possible worlds. He claimed that since the constitution of the Central Electricity Board great progress had been made, notably under the three following heads:—

1. The Grid had been completed with the consequent inter-connection of stations. One hundred superfluous stations had been eliminated, and by next year one single frequency would prevail throughout the country.
2. Before 1926 the reserve plant in generating stations was 83% in excess of the aggregate demand. This reserve had to-day been reduced to 40%, with the consequent liberation of hitherto idle capital for revenue earning purposes.
3. The cost of electricity delivered wholesale through the Board now averaged ½d. per unit, as compared with an average of 1d. per unit 10 years ago.

Distribution Policy

Although the Minister admitted that distribution costs per unit sold had remained practically constant during the last 11 years, it was evident that he had not as yet decided upon any policy to deal with distribution. It may well be that the question is one which could best be solved by natural evolution, which is bound to tend to the gradual elimination of the smaller and less efficient units. Politicians are naturally slow to appreciate that there are many problems, particularly industrial problems, which can never be solved by State interference, and, while the more sanguine of them are itching to legislate, it may well be that the wiser heads in the industry itself are anxious for nothing so much as freedom from bureaucratic interference.

This may be the main lesson of the debate for our own Industry, although at least two other aspects must not be overlooked. Firstly, any attack on gas was entirely absent from all the speeches. Exaggerated claims were, of course, made with regard to the benefits to be procured by the spread of electricity, but there was no suggestion by any member that could be regarded as being directly detrimental to the great service rendered by the Gas Industry to the people of this country. Secondly, it is well to call attention to the words uttered by Mr. J. C. Ede, M.P., who suggested that in the rural district electricity is not in competition with gas so much as with oil cooking, and he did not think that even in the town electricity is so much in competition with gas as with the can opener. There are, he said, still a number of women who, when they came home from the bridge party, consider that it is somewhat quicker to get their husband's supper ready by producing a can opener and opening a tin than to provide him with something fresh, but in the rural districts competition is only with oil. The advantages of electricity in those districts, he concluded, are too easily demonstrable ever to be missed by the housewife.

Forthcoming Engagements

Dec.

8.—N.G.C.—Meeting of the Central Executive Board, 11 a.m.
9.—Manchester and District Juniors.—Visit to J. H. Robinson & Co. (Liverpool), Ltd. Paper by F. Bell.
9.—B.C.G.A.—Midland District Conference at Stoke-on-Trent.
12.—Scottish Juniors.—Joint Meeting at Glasgow. Address by R. Robertson (Junior Vice-President, I.G.E.).
12.—Yorkshire Juniors.—Meeting at Barnsley; Paper by J. A. Derbyshire.
12.—Western Juniors.—Meeting at Exeter. Paper by H. Oliver.
16.—B.C.G.A.—Executive Committee Meeting, Gas Industry House, 11.30 a.m.
17.—S.B.G.I.—Council Meeting at 2.30 p.m.
18.—London and Southern Juniors.—Meeting and Paper by J. Grayston.

Jan.

2.—London and Southern Juniors.—Visit to Fuel Research Station, Greenwich.
9.—Scottish Eastern Juniors.—Visit to Alder & Mackay, Ltd., Edinburgh.
9.—Scottish Western Juniors.—Paper by W. Gledhill, of Stirling, "Development of a Gas-Works Amalgamation."
14.—Midland Juniors.—Paper by G. E. Stevenson, of Long Eaton, "Obtaining the Goodwill of the Consumer."
16.—Yorkshire Juniors.—Meeting at Sheffield. Paper by A. E. Wilson, "My Last Twelve Months with Industrial Gas."
22.—London and Southern Juniors.—Paper by T. J. Legge and T. G. Noble, "Baffler Performance in Relation to the Safety of Gas Appliances."
23.—Midland Juniors.—Visit to Walsall Gas-Works.
23.—Scottish Western Juniors.—Visit to Port Glasgow Gas-Works.
23.—Western Juniors.—Visit to Works of Swindon United Gas Company. Paper by D. A. Vince, of Swindon.
23.—Wales and Mon. Juniors.—Meeting at Neath. Paper by D. Rees, of Neath, "Reconstruction of an 1877 Gasholder."

Gas Journal Shewring Fund

Donations are invited to the Fund, full particulars of which were given in the "JOURNAL" for July 22. The Management of the Fund is in the hands of Messrs. F. G. Shaw (Buxton), W. W. Townsend (Colchester), and J. Bridge (Elland). All expenses having been guaranteed, the whole of the sums received will be applied, without any deduction whatsoever, to the benefit of the widow and children of Harold Shewring, by whose tragic death earlier this year they were left in distressed circumstances.

Cheques should be made payable to the "GAS JOURNAL," and crossed "Shewring Fund Account." All donations will be gratefully acknowledged by the Editor, who is Treasurer to the Fund.

We are pleased to be able to announce that the total to date amounts to £851 7s. 4d.

Personal

Retirement of Mr. James Macleod, F.I.C., M.I.Chem.E.

On Dec. 1, Mr. James Macleod retired from the General Managership of the Glasgow Corporation Chemical Works, a position he had held since 1925. This Department controls four works, and during Mr. Macleod's tenure these have been re-equipped and overhauled.

Mr. Macleod had a long connection with the Gas Industry. For 16 years he acted as Chemist and Chief Chemist to the Glasgow Gas Department. Later he held the post of Engineer and Manager at Kirkintilloch and subsequently at Greenock.

His success in the development of by-product recovery resulted in his being invited to become General Manager in Scotland for Messrs. Brotherston, of Leeds, and he took charge of the Provan and Dawsholm Works. He then became Superintendent of the Coke Ovens, and Chief Chemist to Messrs. James Nimmo & Co., Ltd., and was responsible for the erection of a modern battery of coke ovens, which provided a supply of surplus gas to Glasgow Corporation.

Mr. Macleod was the first to take the F.I.C. by examination in Chemical Technology. He was an Honours Medallist in Gas Engineering of the City and Guilds of London Institute, taking first place in the United Kingdom. For six years he filled the Lectureship in Gas Engineering in the Royal Technical College, Glasgow, where he received his earlier training. He has contributed extensively to research on this subject.

He has always been a man of wide interests, and has taken an active part in the work of local scientific societies. He acted as Chairman of the Local Sections of both the Institute of Chemistry and the Society of Chemical Industry. He was President of the North British Association of Gas Managers, and a Member of Council of The Institution of Gas Engineers, as well as Member of Committee of several Panels dealing with the Standardization of Tar Products.

Mr. Macleod's services are not to be lost altogether, for he is setting up as Consulting Chemical and Gas Engineer immediately on his retirement, at Baltic Chambers, 50, Wellington Street, Glasgow, C. 2.

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Presentation to Mr. William Stanford

A large gathering, representative of all departments of the Newport (Mon.) Gas Company, and many friends were present when Mr. J. H. Canning, O.B.E., J.P., Engineer and Manager, presided and made a presentation to Mr. William Stanford, Secretary, of a pair of Zeiss binoculars and a silver sugar dredger. Mr. Stanford had previously been the recipient of a handsome silver tea and coffee service from the Directors of the Company.

The presentations were made as a mark of esteem on the completion by Mr. Stanford of fifty years' faithful service to the Company. Referring to Mr. Stanford's work for his Church, Mr. Canning said that like the theme running through a symphony, so Mr. Stanford's religion ran through the whole of his life's activities, unobtrusively so he knew, but, he felt that here was the basis upon which that life had been built, and he hoped Mr. Stanford would not mind his referring to it. Mr. Canning said that Mr. Stanford had given fifty years of devoted and faithful service, and he outlined the latter's career, details of which were given in the "Journal" for Sept. 23. The best wishes of the whole staff were conveyed by Mr. Canning, who heartily congratulated Mr. Stanford on his extraordinary record.

Mr. R. S. Snelling, who has been closely associated with Mr. Stanford for many years, referred to the happy relations which existed between Mr. Stanford's personal Staff and Mr. Stanford himself. He expressed their appreciation of the inspiring example of steadiness and integrity which Mr. Stanford has constantly set them.

Mr. J. F. Rust, Assistant Engineer, extended congratulations on behalf of the Engineering Department Staff, and associated himself with the tributes and good wishes already expressed. Miss E. M. W. Jones, on behalf of the Ladies, Mr. R. M. Jones, on behalf of the Works Departments, and Mr. W. J. Yendall also joined in the congratulations and good wishes for the future.

Mr. R. J. Auckland, Secretary of the Cardiff Gas Light and Coke Company, referred to the very great benefit which accrued to both Companies from the cordial co-operation of the Chief Officials, and said that Mr. Stanford's ability and kindliness were very much valued by his friends in the Gas Industry. The Rev. W. J. Mountford (Superintendent of the local Methodist Circuit) expressed his great pleasure at being present to listen to the exceptional tributes paid to one who was so deservedly liked and admired in his own Church Circles.

Replying, Mr. Stanford thanked Mr. Canning and the other speakers for the too generous tributes they had paid to himself and his services, remarking that at times he had experienced a feeling of detachment from the proceedings, and that what was said had to do with some other than himself. He quoted incidents and circumstances illustrating changes and advances that had taken place in the half-century of his association with the Company, as, for instance, the reduction in the time taken by a railway journey to London from six to two-and-a-half hours, and the growth in the Gas Industry, from one catering for lighting only, and that in pre-electric days, with flat-flame burners, to one ministering to the multifarious needs of the community as it does to-day. He recalled Officials of the Company and members of the Staff with whom he had been associated, and expressed his appreciation of the way in which the occasion had been recognized both by the Directors and the Staff.

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His many friends in the Industry will be sorry to learn that Mr. W. E. Price, late Honorary Secretary of The Institution of Gas Engineers, was taken seriously ill while on holiday at Sidmouth.

He has now been able to return to his home, "Heather Hills," West Chobham, Surrey, but his condition, although somewhat improved, continues to give cause for grave anxiety.

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The high esteem in which Mr. H. Wilkinson, Engineer and Manager of the Slough Gas Company, is held by his staff and workmen was evidenced recently when he was presented with an inscribed wrist watch.

Mr. Williams, Assistant Manager, who was unable to be present owing to illness, offered his congratulations in a letter, saying that he was sure that the men would agree with him when he said that they felt that Mr. Wilkinson had the welfare of the workmen at heart, and that they held him in high esteem both as a gentleman and as Chief. The presentation was made to Mr. Wilkinson by Mr. W. Allen, works foreman, who, in a brief speech, paid a high tribute to the work he had rendered in the interest of the Company. Mr. Wilkinson suitably replied.

Mrs. Wilkinson was also the recipient of a suitable gift.

Obituary

The death occurred on Nov. 27 of Mr. Hugh Symington Davis, B.A.(Cantab), of Merrystone, Coatbridge, a Director of the Coatbridge Gas Company.

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The death took place at the end of last week of Mr. James Gemmell, who until a year or two ago was Manager of the Melrose Gas Company.

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The death took place suddenly on Thursday, Nov. 26, at the Royal Masonic Hospital, of Mr. Ernest Edward Grimwood, Proprietor of Lavenham Gas-Works. He was 50 years of age.

Mr. Grimwood was the younger son of the late Mr. C. W. Grimwood, of Sudbury. He was educated at Sudbury Grammar School and Framlingham, afterwards being articled to Messrs. Alexander Wright & Co., London, scientific and gas instrument makers. After nine years in London he joined the Precision Instrument Company, in Detroit, U.S.A. From there he went to the Ford Works, where he was engaged as a draughtsman. He returned to England about 1920, and again entered the Gas Industry, taking up residence in Lavenham.

News in Brief

Among the New Companies recently registered in Scotland is Calor Gas (Scotland), Ltd., having a capital of £12,000 in £1 shares.

The Thornhill Gas-Works have been acquired by Mr. John J. Halliday, Thornhill, Dumfriesshire, who will continue to make and supply gas for consumers in that district.

The Central Executive Board of the National Gas Council will hold their next meeting in Committee Room No. 4 at Gas Industries House, 1, Grosvenor Place, S.W. 1, at 11 a.m. on Tuesday, Dec. 8.

To Replace the Gasholder at Meadowflat, it was decided by the Edinburgh Public Utilities Committee on Friday, Nov. 27, that a new spirally-guided gasholder with capacity of 1,000,000 cu.ft. will be erected.

The Leipzig Spring Fair will open on Feb. 28. The General Samples Fair will continue until March 5 but the Great Engineering Fair and Building Fair will run for three extra days—*i.e.*, until March 8, 1937.

Applications are Invited for the position of Assistant Engineer to the Romford Gas Company. This appointment, to which further reference is made in our advertisement columns to-day, carries a commencing salary of £400 per annum.

Gas Equipment is to be installed by the Nantwich Urban Council in the Technical Institute. The County Authority are strong supporters of electricity for lighting the building, and offered to pay for the cost of installing electricity, but an amendment to this effect was lost.

Applications are Invited by the Chorley Gas Department for the position of Technical Assistant to the Gas Engineer. Further particulars of the position, which carries a commencing salary of £270 rising by annual increments of £15 to £315 per annum for satisfactory service, will be found in our advertisement columns.

Christmas Fare Demonstrations are now running at the showrooms of the Leamington Priors Gas Company. The demonstrator is Miss M. Harris, N.S.T.C., M.C.A., of Messrs. Sidney Flavel & Co., Ltd. The demonstrations were opened on Monday, Nov. 30, by the Mayoress of Leamington, Mrs. C. H. Southorn. A Christmas cake-baking contest has been arranged in connection with the demonstrations.

Tenders for £2,000 5% Perpetual Preference Stock (Water Undertaking) and £1,000 5% Perpetual Debenture Stock (Gas Undertaking), the minimum price in both cases being £120 per £100 stock, will be received by the Directors of the Sheringham Gas and Water Company at their London offices, Temple Chambers, Temple Avenue, E.C. 4, on or before 11 a.m. on Dec. 10. Details will be found in our advertisement columns.

"**Standing Room Only**" was announced long before the Demonstrations were billed to begin at Spalding last week. The inclusion of special Christmas dishes proved a great attraction, and numbers benefited by the advice given by Madame Feilden, M.C.A., Demonstrator for Cannon Iron Foundries, Ltd. Under the able guidance of Mr. J. Demain, Engineer and Manager, Spalding Gas Department, the series of lectures in the new showrooms have been very popular.

The Abolition of the Post of Public Lighting Inspector was decided upon by a sub-committee of the Dundee Corporation and the Lighting Committee on Nov. 23. The office was vacant and will, therefore, not be filled. Mr. R. D. Robertson, who has held the post since 1923, is retiring on superannuation. Convener P. Gillespie said the office was redundant. They should now hand the lighting of the City over to the Gas Department and the Electricity Department.

A Visit was Paid to the Stechford Works of the Parkinson Stove Company on Wednesday, Nov. 25, by the Birmingham Midland Branch of the Institute of British Foundrymen. An extensive tour of the works was undertaken and the visitors were particularly interested in the operations of the foundry and enamel departments. The party were afterwards entertained at tea by the Directors of the Company, at the conclusion of which Mr. G. W. Brown, Branch President, proposed a vote of thanks to the Company for the hospitality and the guides for their courtesy and attention during the tour of the works. Mr. W. Todd, Works Manager, responded on behalf of the Parkinson Stove Company, Ltd.

Mr. R. Summerson, President of the London and Southern District Junior Gas Association, writes to point out two misprints which occurred in the section of his Presidential Address dealing with water softening in last week's "JOURNAL." The reaction quoted in the fourth paragraph should read: Na_2O, Al_2O_3, x SiO_2, y H_2O + $CaCl_2 \rightleftarrows$ CaO, Al_2O_3, x SiO_2, y H_2O + 2NaCl. Under the heading "Properties of Zeolites," the fifth line should read . . . (CaO) or calcium carbonate ($CaCO_3$) in lbs. or grains ex- . . .

Activity of an Unusual Kind prevailed at Belfast Gas offices on Monday, Nov. 23, when the majority of the staff vacated the City Hall and took over occupation of the new offices in Ormeau Avenue. In recent years the increase in the work has been such as to render their accommodation at "headquarters" inadequate, and in consequence of the overcrowding the staff welcome the change to the more commodious, if slightly less central, premises. The work of changing over occupied only a very few hours. Under present arrangements the pay counters and cashiers will remain at the City Hall, but all other work will be done at Ormeau Avenue.

Joint Parliamentary Committee on Gas Charges

Personnel Announced

The composition of the Joint Parliamentary Committee which has been appointed to consider the question of Gas Charges was announced last week as follows:

From the House of Lords.

Viscount RIDLEY.

Lord SALTOUN, M.C., Elected a Scottish representative Peer, 1935.

Lord O'HAGAN, Member of Ecclesiastical Commission of Essex T.A.C.A.; Past-Chairman Central Chamber of Agriculture; Past-President of Dairy Farmers' Association; County Director and Controller B.R.C.S., Suffolk Branch; Member of Council of C.L.A.; Member of King's Roll National Council; Assistant Private Secretary to First Lord of the Admiralty, 1906-07; Member of National Executive Committee of National Playing Fields Association and of Council of Central Landowners' Association.

Lord MERTHYR, M.A., J.P., County Pembroke, 1925; D.L., 1932; Vice-Chairman Pembrokeshire Quarter Sessions, 1935; Member of Pembrokeshire County Council since 1928; Hon. Treasurer, University College of Wales, Aberystwyth; Member of Council of R.S.P.C.A., 1934.

Lord CARNOCK, M.C., A.D.C. to the Viceroy of India, 1911-13; Barrister Inner Temple.

Lord RUTHVEN, of Gowrie, D.L., J.P. for Lanarkshire.

Lord SANDERSON, Tutor and Lecturer in Economics at Ruskin College, Oxford, 1907-16; Principal, 1916-25; Member of the Central Executive of the Workers' Educational Association since 1915; Editor of the *Industrial Outlook*.

From the House of Commons.

Rt. Hon. Sir FRANCIS DYKE ACLAND, Bt., P.C., D.L., Opposition Lib., Devonshire, Barnstaple Div.

Sir ALAN GARRETT ANDERSON, G.B.E., C., City of London; a Director of the Bank of England and other Companies.

Major PETER S. SHAW, C., Wavertree Div. of Liverpool.

ROBERT CRAIGMYLE MORRISON, Co-op. and Lab., Tottenham, N. Div.

R. J. TAYLOR, Lab., Morpeth; a checkweighman.

J. S. HOLMES, Lib. Nat., Essex, Harwich Div.; Managing Director of Beecham's Pills, Ltd., and a Director of Wharncliffe Silkstone Collieries, Ltd., and other Companies.

CHARLES URIE PEAT, M.C., F.C.A., C., Darlington; of Peat, Marwick, Mitchell, & Co., Chartered Accountants.

Gas Appliances

Announcement of Price Alteration

At the moment of going to Press we have received the following notice which has been issued under date Nov. 30—

During the past two years the cost of labour and raw materials has steadily advanced, but we have so far refrained from increasing our prices to customers.

We regret, however, that it has now become absolutely necessary to recover part of our increased cost of manufacture.

We, the undersigned, therefore announce that, in respect of orders placed on and after Dec. 1 next, our terms will be as follows:

For all goods supplied at net prices 5% advance.

For all goods supplied at list prices standard discount will be reduced by 2½%.

Arden Hill & Co.
Bratt Colbran, Ltd.
Cannon Iron Foundries, Ltd.
Carron Company
Clarks Stove Company, Ltd.
Davis Gas Stove Company, Ltd
Emscote Foundry Company, Ltd.
Falk, Stadelmann, & Co., Ltd.
Sydney Flavel & Co., Ltd.
Forth and Clyde and Sunnyside Iron Companies, Ltd.
Fletcher, Russell, & Co., Ltd.
General Gas Appliances, Ltd.
John Harper & Co., Ltd.
R. & A. Main, Ltd.
The Parkinson Stove Company, Ltd.
Richmonds Gas Stove Company, Ltd.
R. Russell & Sons, Ltd.
Stoves, Ltd.
Wm. Sugg & Co., Ltd.
Vulcan Stove Company, Ltd.
Wilsons and Mathiesons, Ltd.
John Wright & Co., Ltd.

Amalgamation and Grouping

Associated Gas and Water and Yorktown (Camberley).

The Directors of Associated Gas and Water Undertakings, Ltd., announce that the Company has acquired a majority interest in the Yorktown (Camberley) and District Gas and Electricity Company.

Conway Gas Company, Ltd.

It will be recalled that Stellite, Ltd., of Queensferry, Chester, recently acquired the Undertaking of the Conway Corporation. The fact was recorded in these columns on Oct. 7.

Notice is given in the *London Gazette* for Nov. 24 of the intended application to the Board of Trade by the Conway Gas Company, Ltd., for a Special Order under the Gas Undertakings Acts, 1920 to 1934. The address of the Conway Gas Company is given as being at the Stellite Works, Queensferry, near Chester. The objects of the Order provide *inter alia* for the transfer to and vesting in the Conway Gas Company of the Gas Undertaking of the Conway Corporation, in accordance with the terms of an agreement dated Nov. 12 last, made between the Conway Corporation, the Company, and Stellite, Ltd. The Order also seeks powers to enable the Company to contract with Stellite, Ltd., for the purchase from or supply of gas in bulk to Stellite, Ltd.

Gas Consolidation and Uppingham.

Gas Consolidation, Ltd., has made an offer to acquire all the issued Ordinary shares of the Uppingham Gas Light and Coke Company.

Holders have the option of accepting cash or shares on the following basis: For each £10 Ordinary share either (*a*) £16 in cash or (*b*) 14 "A" £1 Ordinary shares, together with 12s. in cash. The shares offered in exchange will rank for dividend from Dec. 1, 1936. The offer is conditional on the acceptance not later than Dec. 7.

Runcorn and Frodsham.

We understand that the Runcorn Gas Company is to hold an extraordinary general meeting of shareholders on Tuesday, Dec. 15, to consider a proposal for the transfer of the Undertaking of the Frodsham Gas and Water Company to the Runcorn Gas Company. If the recommendation is approved, application will be made to the Board of Trade for a Special Order to give effect to the provisional agreement to be entered into between the two Companies to raise additional capital by stock or shares, and by borrowing, and to change the name of the Runcorn Company to that of "The Runcorn and District Gas Company."

Severn Valley and Chepstow.

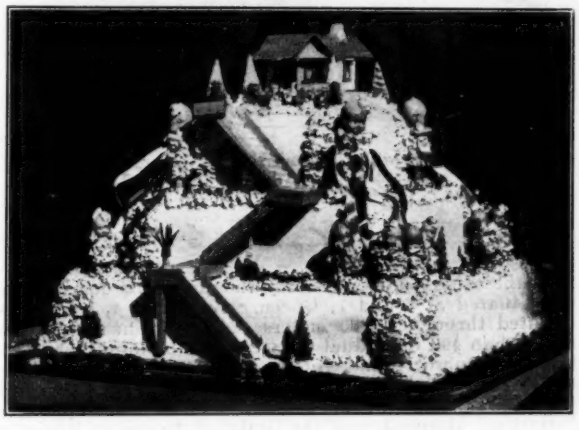
The Severn Valley Gas Corporation, Ltd., is seeking to acquire the Chepstow Gas Company and has made the following offer to the shareholders. For each £100 of Chepstow Gas Stock, either: (*a*) £85 in cash, or (*b*) 80 Ordinary shares of £1 of Severn Valley. Cash at the rate of 22s. 6d. for each Ordinary share of £1 will be paid in respect of any such share which on allotment at these rates would fall to be allotted in fractions.

The shares of Severn Valley offered in exchange will rank for dividend from Oct. 1, 1936. The offer is conditional on acceptance not later than Dec. 7.

United Kingdom and Hoylake.

It was stated at a recent meeting of the Hoylake Urban Council that the United Kingdom Gas Corporation, Ltd., had made an offer to buy the Council's Gas Undertaking and that the Managing Director was to interview the Finance Committee. Capt. Wynn Williams said that the Council had already decided not to sell, so why should they continue to negotiate. Mr. Doleman replied the Council only decided not to sell at the price mentioned. A proposal that the decision to see the Director be deleted from the minutes was lost.

A Wanganui Creation



"A dream-cake' best describes the impression this cake must have created in the minds of the Local Children's Garden Circle for whose birthday celebrations it was specially made by a Radiation demonstrator at Wanganui, New Zealand. The Children's Garden Circle has a membership of 900 children who have little gardens of their own. Every year a competition is held to judge the best gardens, and for the occasion the "Radiation" demonstrator always makes a birthday cake. The above example of her work was cooked in a "Confectioner's" oven, and contained about 25 lbs. of fruit, 50 eggs, and many other ingredients. All the decorations were made from icing—even the little dolls—in various tasteful shades. The little house on the top of the cake was lighted from inside by electricity, and the cake caused quite a sensation when exhibited in a shop window at Wanganui.

The Woodall-Duckham Company

Recent Orders

Messrs. Richard Thomas & Co., Ltd., have placed an order with the Woodall-Duckham Company for a complete by-product coking installation to be erected at the Ebbw Vale Steelworks as part of the £5,000,000 reconstruction scheme which is being carried out at this works.

The plant will comprise a battery of 65 W-D. Becker coke ovens, designed for heating by blast furnace gas or coke oven gas. The ovens will be capable of carbonizing 1,370 tons of coal a day. In addition to the ovens, the contract includes a complete coal blending, crushing, and handling plant, a by-product plant for the recovery of tar and ammonia in the form of sulphate, crude benzole recovery plant, and plant for grading the coke and handling it to the blast furnaces. About 1,000,000 gallons of benzole per annum will be derived from the coal.

The Nunnery Colliery Company have also placed an order with the Woodall-Duckham Company for a battery of 22 W-D. Becker coke ovens to be underfired by coke oven gas. The daily capacity of the ovens will be 330 tons of coal.

1936 "JOURNAL" DIRECTORY

Page 56. READING. A. B. Stedman, S., deceased.

Page 62. SOUTH SUBURBAN. W. Wastell, G.M., retired.

Page 92. STEWARTON. W. Wilson, E. & M., deceased.

Mr. Therm's Triumphal Entry to the City of London

The Lord Mayor Opens New Showrooms for the Gas Light and Coke Company

Another important milestone in the history of the Gas Light and Coke Company was reached on Tuesday of last week, when the Company's first showrooms in the "square mile" of the City of London, and their sixtieth showroom altogether, was declared open by the Rt. Hon. the Lord Mayor of London, Sir George Broadbridge.

The Lord Mayor with the Governor and other Officials of the Company inspecting the new Showrooms

In the square mile served by the new showrooms, which are situated at 6 and 7, Queen Street, E.C. 4, gas is distributed through 20,000 meters, some of which supply no fewer than 400 individual offices in one building, while the Company numbers among its City consumers such buildings as the Guildhall, the Mansion House, St. Paul's Cathedral, the Tower of London, the City Police Headquarters, "Bart's." Hospital, and the Guildhall School of Music, to mention but a few. Now, for the first time, Mr. Therm will be "At Home" to his City consumers within their own borders, while the new premises have carried the banner of GAS right into the heart of business London—which in itself should have great publicity value.

The whole conception of the new showrooms strikes a thoroughly modern note, and the exterior at once attracts attention by reason of its pleasing facia, with the Company's name in coloured neon letters above a window giving a clear view of the brightly illuminated and pleasingly laid out interior.

The new premises follow in general lines the well recognized principles adopted in the design of recent Gas Light and Coke Company showrooms, though a number of interesting individual features have been introduced to render them more in keeping with the special area they have been built to serve.

Decoration has been carried out in primrose and green, and displayed in the ground-floor showroom is a wide range of all the appliances most suited to the City's needs. Water heaters and fires for office buildings are tastefully set out, while the cooking and refrigeration loads are not forgotten. Attractive lighting fittings indicate all that gas can do in this direction, and a counter is included at the back of the showroom for enquiries and the payment of accounts.

The basement is given over to an excellent display of commercial appliances, including fish-frying ranges, ovens, large refrigerators, and restaurant and canteen cooking apparatus. A particularly interesting feature in this section is that devoted to all the alternative methods of water heating by gas. A range of hand basins appropriately numbered are individually served by various different appliances bearing corresponding numbers and set on an adjacent wall, so that a prospective consumer can judge which system will best fulfil his requirements.

On the first floor is a suite of offices for the Company's district staff.

The Opening Ceremony.

In formally opening the new showrooms, the Lord Mayor of London observed that 'everyone concerned with the government of the City of London had the interests of its industries at heart, particularly when they were associated with a great public utility undertaking like the Gas Light and Coke Company. Declaring the showrooms open, Sir George Broadbridge wished them every success—indeed, the success the Company would wish itself.

Sir David Milne-Watson (Governor of the Company) said how much they appreciated the Lord Mayor's presence on that occasion and thanked him for opening the premises. The Lord Mayor and Sheriffs, in company with the Governor, Deputy-Governor, and other Directors and Senior Officers of the Undertaking, then inspected the showrooms.

Guests of the Company at Fishmongers' Hall.

Subsequently a distinguished gathering, numbering about 170 and representative of many spheres of City activities, was entertained at Luncheon at the Fishmongers' Hall, London Bridge—Sir David Milne-Watson presiding, with the Lord Mayor at his right hand.

The Loyal Toast having been duly honoured, Sir David rose to propose the health of the Lord Mayor, the Sheriffs, and the Corporation of the City of London. In the first place, he thanked them very much on behalf of the Directors of the Company for their presence on that occasion and the Lord Mayor for opening their new showrooms in Queen Street. He thought that the City had found in the Gas Light and Coke Company faithful servants, and the Company for their part had found firm friends in the City. This happy relationship had

A View of the Ground Floor Showroom.

grown increasingly cordial and mutually beneficial as time had gone on. To find a time when it was not so one would need to go many years further back than the memory even of the longest lived among them. But the association between them, which reached its climax that day with the opening of the Company's sixtieth, and the City's first, gas showrooms, had some very stormy beginnings.

The very novelty of the new fuel, said Sir David, brought its critics and detractors. Not that he wanted to suggest that all was entirely well with the gas service of those days. He did not think that there were any instances of serious shortcomings in the City even as far back as those years, though a newspaper report of the eighteen-thirties stated that on the occasion of a visit by William IV. and Queen Adelaide to Brighton "The gas"—to quote the actual words of the report—"was so wholly consumed by the various illuminations that the Brighton Theatre was left in total darkness, and there was no resource left for the management but to sing 'God Save the King' and return the money." Sir David was happy to be able to tell them, however, that so far as that sort of trouble was concerned, gas had never let the City of London down, and

they had certainly never been under the painful necessity of returning their money; and he hoped they never would—not for that sort of reason at any rate.

As these phases in the history of the Gas Industry were working themselves out, so at the same time the range of activity of the Gas Light and Coke Company was growing. Step by step it took over other undertakings operating in the City until in 1883 the Gas Light and Coke Company remained the sole survivor in the field, had continued to remain so ever since, and would, he was confident, continue henceforward as the City's "Public Servant No. 1."

In their new showrooms they would always receive a warm welcome, and he hoped that all those present on that occasion would take an early opportunity of visiting them. In conclusion, Sir David assured the Lord Mayor how very sensible they were to the honour he had done them in coming there that day, and he would ask him to accept a souvenir of the occasion. The Company were greatly honoured by his visit.

To Help the Trade of the City.

The LORD MAYOR, in response, thanked Sir David for the kind manner in which he had proposed the Toast and for the Company's generous hospitality, as well as for presenting him with that delightful souvenir of the occasion. It was the desire, he said, of each Lord Mayor to do all in his power to help trade in the City of London, and therefore it had given him very great pleasure to open that day the first City and sixtieth branch of the Gas Light and Coke Company. He could not understand, he observed, how such a great public utility Company had carried on so long without a branch in the City. How many people walking in the streets stopped to look up at the lamps that lighted the City streets? There were thirty-five miles of streets in the City lighted by the Gas Light and Coke Company, and that very street was one of them. Street lighting was one of the Company's most important functions, and it was now responsible for over 50,000 lamps.

Although the offices of that great Undertaking had been at no great distance from the City, it seemed to him that the fact that they had now come right into the "square mile" must be not only a great convenience to them in their operations in the public's service, but must inevitably help the continued and successful prosperity of such a great Undertaking. When he was invited by Sir David Milne-Watson and the Directors of the Gas Light and Coke Company to perform this happy ceremony he accepted gladly, because they were pleased to pay honour to the largest gas company in the world, numbering five million consumers within its boundaries, which included an area of 540 square miles, from Southend to Windsor. It maintained a system of mains 5,800 miles in length; had a staff of 25,000; had over 10,000 men in direct contact with the public; and its output was 50,000 million cu.ft. of gas a year. It was a remarkable fact, said the Lord Mayor, that apparently throughout the five generations during which gas had served the people of London, it had never once ceased flowing in the mains and service pipes. There could not be many commodities of any kind that could claim such a record. One of the aspects of the public service work of the Company was the conduct of continuous research on a very large scale into every aspect of the manufacture and supply of gas, while another was the contribution of the Gas Industry to the adequate and economic use of Britain's most important resource—its coal supply. The inauguration of the public services of gas had been one of the greatest benefits to mankind in history, and it was difficult to imagine what life would be like without its comforts. He could only hope that the Company would find

The Commercial and Industrial Section.

that its entry into the City would be rewarded with the success such an Undertaking deserved.

It only remained for him once again to express his pleasure at coming to open the new showrooms upon which he congratulated the Company, and to thank them for the extraordinarily nice souvenir as well as for their generous hospitality on that occasion.

In concluding the proceedings, Sir DAVID MILNE-WATSON thanked the Prime Warden of the Fishmongers' Company for so kindly lending them that Hall. It was extremely generous of that Body to allow them to use it for that function; it had added enormously to its pleasure.

The Institution of Gas Engineers

Recent B.S. Specifications

Copies of the following recently issued British Standard Specifications may be obtained, price 2s. each, from the Secretary, Mr. J. R. W. Alexander, The Institution of Gas Engineers, 1, Grosvenor Place, London, S.W. 1:

No. 336-1936.—Fire Hose Couplings (including Screwed Outlets for Hydrants), Suction Hose Couplings, and Branch Pipes and Nozzle Connections.

No. 394-1936.—Short Link Wrought Iron Crane Chain (excluding Pitched or Calibrated Chain). (Superseding No. 394-1930.)

No. 614-1936.—Graduated Receivers for Dean and Stark Apparatus.

No. 705-1936.—Method for the Determination of the Agglutinating Value of Coal.

No. 715-1936.—Sheet Metal Cylindrical Flue Pipes, Fittings, and Accessories for Gas Fired Appliances.

Theatre Tickets and Gas Appliances

An Enterprising Link

A little over two years ago, it will be recalled, the Gas Light and Coke Company started an Authorized Dealers scheme, and to-day over 800 dealers are selling their appliances throughout the Company's area.

An enterprising firm in South Kensington, Rawlings Bros., Ltd., of 95, Gloucester Road, S.W. 7, have opened additional premises at 4, Bank Buildings, Gloucester Road, S.W. 7, adjoining their existing shop, and have hit on the novel idea of combining a gas showroom in collaboration with a branch of Cecil Roy's theatre ticket agency. The display of gas apparatus is so arranged that a customer has to pass through it in order to buy a theatre ticket, for the office is at the farthest end of the room. The idea is that the customer who comes in for a theatre ticket will order a gas fire at the same time or *vice versa*. The incentive is certainly there. Extensive alterations to the premises have lately been carried out. The modern-looking showroom with buff-coloured walls shows off to the best possible advantage a large selection of gas fires with coloured surrounds, refrigerators, cookers, and water heaters. The water heaters are in action giving hot water to a hand basin and a bath for demonstrations to customers.

Cake Baking Competition at Petts Wood

South Suburban Co.'s Activities in New Area

The new residential district of Petts Wood, situated between Chislehurst and Orpington, is as yet without a gas showroom of its own; but pending the provision of such facilities for their many consumers in this area, the South Suburban Gas Company have been stimulating interest in gas by the holding of a cake baking competition recently at the Daylight Inn.

The competition was for a Madeira cake, and the adjudicator, Miss F. E. Dawson, commented upon the high standard attained by the forty-five competitors who entered.

Mr. H. F. Glass, Chairman of the Orpington Chamber of Commerce, distributed the prizes and congratulated the prize-winners on their success. He was particularly pleased, he said, to see so many take an interest in the Company's demonstration, which was arranged solely to help housewives. He thanked Miss Dawson for her help, and expressed the hope that another competition would be arranged in due course.

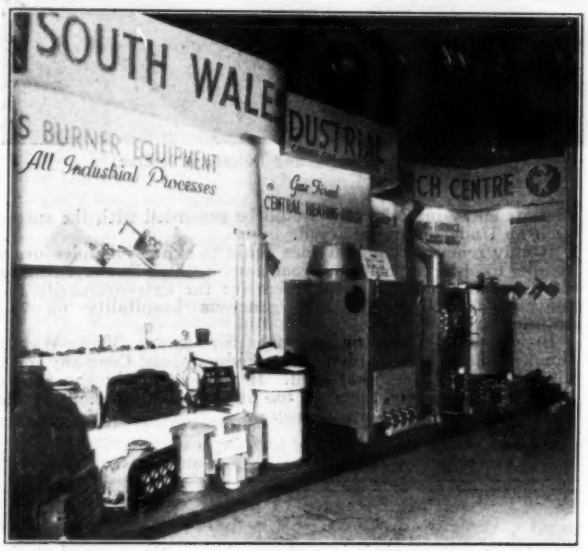
Road Tar Luncheon at Cardiff

Visit to Engineering Exhibition

At the annual luncheon of the British Road Tar Association held in connection with the Engineering Exhibition at the Park Hotel, Cardiff, on Thursday, Nov. 26, Mr. H. D. Madden, Engineer and Manager of the Cardiff Gas Light and Coke Company, took the Chair. There was an excellent attendance, and the luncheon was voted the most successful yet held.

"Prosperity to the Trade of South Wales" was proposed by Mr. S. R. Ham, President of the Cardiff Chamber of Commerce, who expressed the hope that any Government action on behalf of the Special Areas would include introduction of industries ancillary to the coal industry. Responding to the toast, the Lord Mayor of Cardiff, Alderman Herbert Hiles, referred to the improving industrial outlook for South Wales.

"The British Road Tar Association" was proposed by Mr. W. R. Gordon, Director of the Coal Utilisation Council. Mr. Gordon said that the object of the Coal Utilisation Council and the B.R.T.A. were directly or indirectly the same—viz., to promote the sale and efficient use of British coal. There was intense competition between Britain's



South Wales Industrial Exhibit at the Cardiff Engineering Exhibition.

natural and national asset, coal, and imported oil. The C.U.C. had taken its full share in the task of bringing home to fuel users the undoubted fact that there is nothing which imported fuel oil can do for them which cannot be done as well or better, and done more cheaply, by coal or one of its derivatives. In meeting the competition of imported oil, Mr. Gordon continued, the gas and by-product industries had played and were playing a notable part. They acted as an indispensable medium of distribution, and as a result of their various processes the valuable by-products of coal were made available for national use. Why could not that imported bitumen and asphalt be replaced by British Road Tar? The more tar used on the roads the better for British Industry—and for British roads.

Responding, Sir Reginald Clarry, M.P., Chairman of the B.R.T.A., said that he saw no reason why tar from Welsh coal should not be used on every road in Wales and Monmouthshire; it was suitable in quality, in quantity, and in price.

New industries were desirable for the area, but no serious attempt to improve the situation could be made until there was a material increase in the export of coal.

Others present included Mr. L. G. Williams (Chairman, Cardiff Gas Light and Coke Company), Sir Charles H. Bird, J.P.; Mr. E. J. Fottrell (Manager, National Gas Council), Councillor George Williams (Chairman, National Industrial Development Council of Wales and Monmouthshire), Alderman G. Fred Evans, J.P., Messrs. J. H. Canning, J.P. (Engineer and Manager, Newport (Mon.) Gas Company), W. E. Cone (Technical Adviser, B.R.T.A.), F. Graham Bird, W. H. Johns (Engineer and Manager, Swansea Gas Light Company), W. Stanford (Secretary, Newport (Mon.) Gas Company), R. J. Auckland (Secretary, Cardiff Gas Light and Coke Company), and Octavius Thomas.

Visit to the Engineering Exhibition.

After luncheon members of the Association paid an official visit to the Engineering Exhibition, on the invitation of Mr. F. Llewellin Jacob. This was also the occasion of the official visit of the Wales and Monmouthshire Association of Gas Engineers and Managers. The Associations were welcomed by Mr. Jacob, who observed that the engineering industry was of such a catholic nature that it was hard to say where a branch began or ended.

There was much of interest to the visitors at the exhibition, notably the exhibit of the South Wales Industrial Research Centre, where gas equipment for industrial work was effectively displayed. The exhibit was arranged under the direction of Mr. H. D. Madden, Engineer and Manager of the Cardiff Gas Light Company.

Glasgow Section of the S.C.I.

Presentation of Chairman's Badge

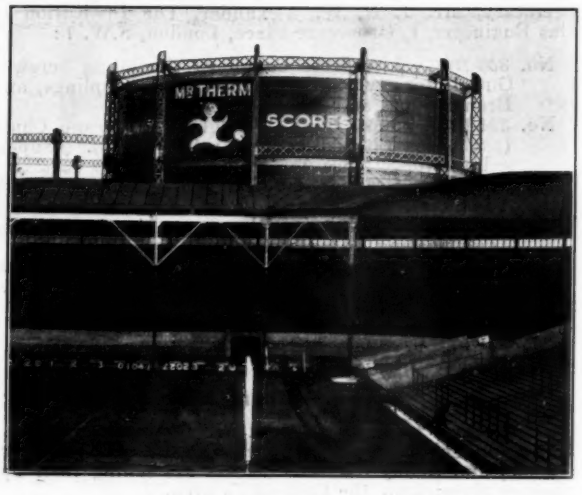
An event of importance in the history of the Glasgow Section of the Society of Chemical Industry took place at the North British Station Hotel, Glasgow, on Nov. 21, when a handsome gold and enamel badge to be worn by the Section's Chairman was presented by Mr. Thomas Ramsay.

A party consisting of the Committee, Past-Chairmen, and their ladies sat down to dinner as the guests of Mr. Ramsay, who was Chairman from 1928 to 1930.

Mr. J. W. Napier, Engineer and Manager to the Alloa Gas Department, who is the present Chairman of the Section, in thanking Mr. Ramsay on behalf of the Section and the Society, said he felt it to be a particular honour to be presiding Chairman on that occasion. He spoke of the Section as he had known it when he first joined it in 1893, mentioning the names of some eminent men in science and industry who had occupied the chair. He then called upon Prof. G. G. Henderson to present replicas of the badge to Past-Chairmen, among whom was Mr. James MacLeod (1916-1918), General Manager of the Glasgow Corporation Chemical Works, a note concerning whose pending retirement appears in our Personal Columns to-day.

The last item on the programme was the presentation to Mr. Ramsay by Mr. Napier, on behalf of the Committee of the Section, of an inscribed silver salver as a tangible gift in appreciation of his services.

Appropriate Gasholder Publicity at Stoke-on-Trent



Our photograph shows an appropriate advertisement on a gasholder of the Stoke-on-Trent Gas Department adjoining the Stoke City Football Ground. The Department have for some time had an advertisement on this holder on account of its position, but this special piece of publicity was prepared in connection with the International Match between England and Ireland played on this ground on Nov. 18.

AUTUMN RESEARCH MEETING

Nov. 3 & 4, 1936

OF THE INSTITUTION

WRITTEN CONTRIBUTIONS AND REPLIES TO THE DISCUSSIONS

Communication No. 140—38th Report of the Joint Research Committee of the Institution and Leeds University. Corrosion from Products of Combustion of Gas—Part IV. Tube Experiments (continued).

Mr. W. SINGLETON (Goodlass Wall Lead Industries, Ltd.) wrote: While a glance through this Report and the preceding one makes one realize the extent of the work involved in carrying out this investigation, a study of the Reports in detail reveals the considerable forethought and thoroughness with which the work has been planned and executed.

I am particularly interested in the results obtained with town gas of low sulphur content especially where they concern lead and lead alloys, because they are in general agreement with observations which have been made by my colleagues and myself when studying the general problem of the corrosion of lead by sulphuric acid. While it is true that the corrosion resistant properties of lead to sulphuric acid are due to the formation of a protective coating, our observations have shown that the formation of this protective coating is by no means entirely dependent on the concentration of the sulphuric acid; in fact, it can be shown, generally speaking, that in most conditions lead is most resistant to sulphuric acid of medium concentration and least resistant to low and high concentrations. A curve showing corrosion over a wide range of concentrations of sulphuric acid is of bowl-like shape. The position and extent of the range of concentration at which the protective coating is most readily formed and *maintained* —represented by the bottom of the bowl shaped curve— appears to depend in large measure on temperature and is, of course, affected by the presence of impurities. Admittedly, these observations are based on investigations made at concentrations greatly in excess of those considered in the Report, but they have nevertheless a bearing on the conditions dealt with in the Report.

When nitric acid is present as in this investigation, the position is made more complicated. The conditions are such that the protective coating is attacked and broken down as it is being formed, by the nitric acid present, and if the protective coating is to survive sufficient sulphuric acid must be present to repair the damage done by the nitric acid and to keep the protective coating in good repair. The ratio between the nitric and sulphuric acids is therefore important in deciding the existence of the protective coating and thus the corrosion resistance of the lead.

The increased corrosion of the lead and solder at the low sulphur concentrations described in the Report may thus be explained as being due not to the low sulphur content *per se*, but to the nitric acid present in excess of the nitric/sulphuric acid ratio necessary to maintain the protective coating intact. For gases of low sulphur content the degree of resistance of lead to corrosion is probably largely determined by the amount of nitric acid present.

The reports are of considerable interest not only to the Gas Industry, but to those interested in corrosion problems in general; and I think the Authors are to be congratulated on having completed an investigation which must be of great practical value to the Gas Industry.

Written Reply of Mr. Wood.

Mr. JAMES W. WOOD (Research Chemist), in reply, wrote: Our thanks are tendered to those gentlemen who have taken part in the Discussion of the Report, and have emphasized some of the lessons to be drawn from it, as well as calling attention to gaps which still remain in our knowledge.

It was not unreasonable at the outset to assume that reduction in the sulphur-content of town gas would lead to reduced corrosion troubles. In certain quarters it was even suggested that small reductions in sulphur content would produce disproportionately large benefits in this direction. It was clearly desirable, therefore, that the true state of affairs should be ascertained experimentally, in order that the additional purification costs might be properly balanced against savings on the maintenance side of the Industry. Complete removal of sulphur, stressed by several speakers, is the ultimate ideal, and it is realized that apart from the question of reduced corrosion, a low sulphur content will facilitate the extension of business, especially with flueless heaters. The prospects of achieving a considerable reduction in the sulphur content of town gas are much brighter than when the corrosion investigation was initiated, as may be seen from the Report on the Removal of Sulphur Compounds from Town Gas down to 10 Grains per 100 Cu.Ft. (Communication No. 146).

The desirability of making parallel corrosion experiments under conditions of partial condensation is fully appreciated, but the difficulties of standardizing conditions of test, and giving the results a quantitative significance are very great. The results, also, might differ materially from those already reported, and it is for this reason that the Committee was averse to generalization, and insisted upon attention being called very pointedly to the conditions of full condensation employed in the work so far reported upon. The filling of the gap between corrosion under fully-condensing and high temperature condensing conditions is the obvious piece of work when corrosion investigations are resumed.

As regards oxides of nitrogen, it should be made clear that while traces of these are present in town gas itself, by far the greater amounts are produced during combustion. Some may be produced by the combustion of traces of ammonia and other nitrogen compounds in the gas, but it is well established that they can also be produced during the combustion of fuels completely free from nitrogen. It is not unreasonable, therefore, that oxidation of some of the nitrogen of the air necessary for combustion accounts for the presence of the oxides, and no scheme for the treatment of the gas will entirely eliminate them. On the other hand, the type of gas used, the intensity of combustion, and other conditions, especially the excess of air, might be expected materially to influence the amounts produced. I assume that it is a study of such factors that Dr. Hartley has in mind, as a subject for further investigation.

Both Dr. Vernon and Mr. Singleton have stressed the importance of the formation of protective coatings in the case of metals with which they are respectively familiar, and confirm the views expressed in the Report as to the manner in which such coatings are formed. It is not certain whether the protective coating in the case of solder is stannic oxide or lead sulphate.

As regards dezincification of brass, the mechanism suggested by Dr. Vernon is accepted as accounting for a larger zinc/copper ratio in the condensate than in the brass. It is not, however, clear as to why the phenomena should be exhibited to a marked degree only with a gas of low sulphur content.

When the earliest corrosion results were available it seemed that the amount of metal removed in solution formed so large a proportion of the total corrosion that it could be taken as a measure of corrosion. As the sulphur content of the gas was reduced deposits became relatively more important and could no longer be neglected. The later results were therefore reported for total metal corroded. Considerable re-writing would be necessary to report all the results on a strictly comparable basis, and it was felt that the slight error in the earlier work did not warrant this.

It was evident from the examination of the metal tubes at the end of each experiment that the corrosion was not uniformly distributed, the lower portions usually suffering more severely than the upper. It was not possible, however, to allocate the corrosion quantitatively, but within

the period of the tests there was very little localized action. Aluminium and zinc did show some pitting, but it was in the form of a large number of small shallow pits rather than a few deep ones.

Since the present Report was written certain further points relevant to the investigation have been examined, and it is felt desirable, for the sake of completeness, to incorporate the results in this Written Reply.

Acidities of Condensates from Tests I and II.

Direct determinations have been made of the acidities of a number of stored samples of condensate from Tests I and II, thus permitting the extension of Table 9, p. 41. to cover the whole range of sulphur values, and repairing the omission noted on p. 44, par. 3.

Bearing in mind the length of time some of the samples have been stored, the determined acidities are in satisfactory agreement with the calculated values, the "order" of which may thus be regarded as confirmed. A general increase in the free acid with increasing sulphur content of the gas is observable, although in the cases of copper and brass the free acid was higher in Tests IA and IB than in Test II, for which fact no explanation can be offered.

Production of NO During Combustion.

Despite the attention given to nitrous and nitric acids in the condensates of the 34th, 36th. and 38th Reports, no corresponding determination was made of the amounts of NO produced during combustion, the data of the 28th Report (1931) being accepted in this connection. Recently, three series of determinations were made of the amounts of NO produced by flat-flame burners similar to those used in the corrosion tests, but housed for convenience in the combustion chamber of a Junkers Calorimeter. The "Bottle Method" of the 28th Report was used in conjunction with phenol sulphuric acid for the determination of the NO (*ibid.* p. 52).

TABLE 11.—*Acidity of Condensates: Tests* I *and* II.

Metal.	Milligramme Equivalents per 100 c.c. of Condensate.*		
	Calculated.	Found.	Difference.
1	2	3	4
TEST IA.—26·1 gr. Sulphur per 100 cu.ft. gas burned (Low CO_2).			
Lead	0·351	0·311	0·040
Tin	0·400	0·351	0·049
Solder	0·364	0·333	0·031
Chromium plate	0·419	0·399	0·020
Nickel plate	0·775	0·699	0·076
Brass (70/30)	0·577	0·820	−0·243
Copper, hard	0·959	0·964	−0·005
Copper, soft	0·944	1·062	−0·118
TEST IB.—25·6 gr. Sulphur per 100 cu.ft. gas burned (High CO_2).			
Lead	0·584	0·565	0·019
Tin	0·534	0·471	0·063
Solder	0·498	0·449	0·049
Chromium plate	0·473	0·446	0·027
Nickel plate	0·651	0·615	0·036
Brass	0·730	0·714	0·016
Copper, hard	0·762	0·733	0·029
Copper, soft	0·966	0·793	0·173
TEST II.—51·2 gr. Sulphur per 100 cu.ft. gas burned.			
Lead	0·847	0·840	0·007
Tin	0·781	0·798	−0·017
Solder (1)	0·763	0·768	−0·005
Solder (2)	0·648	0·650	−0·002
Brass (70/30)	0·631	0·636	−0·005
Copper, hard (1)	0·640	0·712	−0·072
Copper, hard (2)	0·595	0·626	−0·031
Copper, soft	0·627	0·646	−0·019
Zinc	0·034	0·200	−0·166

* Total acidity, expressing difference between (sum of sulphuric + nitric acids) and (sum of bases).

TABLE 12.—*Production of NO by Flat Flame Burners.*

Test No.	Gas Rate, Cu.Ft. per Hour, 60° F. 30 in. Wet	Gas.			Products of Combustion.			Condensate		Oxides of Nitrogen expressed as NO.			
		CO_2 Produced per Cu.Ft. Gas, Per Cent.	N_2. Per Cent	Air Regd. per Cu.Ft. Gas, Cu.Ft.	CO_2 in Sample, Per Cent.	O_2 in Sample, Per Cent.	CO_2 in Air-free Products. Per Cent.	Inlet Calr. Temp., °C.	Per Cu.Ft. Gas, C.c.	Parts per 10,000 by Vol. in Sample.	NO/CO_2 Ratio by Vol.	NO in Parts per 10,000 by Vol. in Air-free Products.	NO in Parts per 10,000 of Gas Burned.
1	2	3	4	5	6	7	8	9	10	11	12	13	14
Town Gas—Sulphur content approximately 25 gr. per 100 cu.ft													
1	6·17	48·1	6·8	3·88	9·9	5·4	13·3	14	21·3	0·59	0·00060	0·79	2·86
2	6·16	48·6	7·4	3·93	9·7	5·7	13·3	14	21·0	0·55	57	0·75	2·75
3	6·16	44·2	6·8	4·01	8·8	5·6	12·0	13·5	22·3	0·55	63	0·75	2·78
4	6·12	44·0	6·5	3·96	8·9	5·5	12·1	14	22·4	0·59	66	0·80	2·92
5	6·11	44·3	6·4	3·95	8·9	5·7	12·2	14·5	22·5	0·52	59	0·72	2·61
6	6·10	47·7	6·6	3·95	9·5	5·7	13·0	15	21·5	0·64	67	0·87	3·21
7	6·14	43·8	6·8	3·95	8·8	5·7	12·1	14·5	21·9	0·57	62	0·78	2·85
Average	6·14	45·8	6·8	3·94	9·2	5·6	12·6	14·2	21·8	0·57	0·00062	0·78	2·85
Stripped Town Gas—Sulphur content approximately 0·6 gr. per 100 cu.ft.													
8	6·05	39·9	8·1	3·77	7·8	6·7	11·5	17	21·7	0·53	0·00068	0·78	2·70
9	6·20	..	..	..	8·0	6·9	11·9	16	20·9	0·60	75	0·89	..
10	6·23	41·6	7·6	3·84	8·2	6·4	11·8	15·5	20·2	0·56	68	0·81	2·84
Average	6·16	40·8	7·9	3·80	8·0	6·7	11·7	16·2	20·9	0·56	0·00070	0·83	2·77
Town Gas—Sulphur content approximately 23 gr. per 100 cu.ft.													
11	6·23	43·0	8·1	3·94	8·6	5·8	11·9	14	20·3	0·63	0·00073	0·87	3·14
12	6·27	46·3	8·3	3·96	9·1	5·9	12·6	14	19·9	0·62	69	0·87	3·18
13	6·24	46·2	8·1	3·97	8·7	6·4	12·6	13·5	20·4	0·51	58	0·73	2·70
14	6·14	43·0	8·7	3·96	8·5	5·8	11·8	12	21·2	0·61	71	0·84	3·07
15	6·23	42·8	8·6	3·90	8·4	6·0	11·9	10	21·0	..	..	..	..
Average	6·22	44·6	8·3	3·96	8·7	6·0	12·2	13·4	20·4	0·59	0·00068	0·83	3·02

The results, given in Table 12, show an NO production of the same order as that given in the 28th Report, although the values obtained are slightly smaller throughout. As the samples were taken from the flue outlet of the calorimeter the NO production should be increased by approximately 10 per cent. for nitrogen acids removed in the condensate.

Upon p. 42 of the present Report it was suggested that a change in the sulphur content of the gas burned might possibly affect NO production. The comparative experiments of Table 12 with stripped and unstripped gas, however, show no evidence that NO production is influenced to any significant extent by the removal of sulphur.

Examination of Condensates from Calorimeter.

Some of the condensates collected during the above series of tests were carefully examined, as it was believed that they might furnish further information with regard to the corrosion of copper.

When the condensate from the combustion of town gas was allowed to fall directly from the calorimeter into an acidified solution of N/10 potassium permanganate, a much higher oxygen consumption was indicated than in any of the corresponding corrosion-tube experiments, and the high values of the 33rd Report, p. 21, were confirmed. If, however, the condensate were allowed to stand in an open flask before titration with permanganate the oxygen consumption fell with the time of exposure, and results

TABLE 13.—*Composition of Condensates from Calorimeter and Effects of Exposure Thereon.*

Gas Used	Town Gas.					Stripped Gas.		
Test No. from Table 12.	11	13	14	14A	15	8	9	10
Period of Exposure Between A and B in Days	1	4	9	..	6	1	..	..
1	2	3	4	5	6	7	8	9
C.c. $\frac{N}{10}$ $KMnO_4$ per 100 c.c. condensate A	27·0	..	26·0	..	25·6	3·5	3·4	..
C.c. $\frac{N}{10}$ $KMnO_4$ per 100 c.c. condensate B	19·0	..	3·3	..	13·7	2·2	..	..
Diminution in oxygen consumption, per cent.	29·7	..	87·3	..	46·3	36·5	..	..
Sulphur content of condensate in gms. per 100 c.c. A	..	0·0526	0·0551	0·0508	0·0555	..	..	0·0021
Sulphur content of condensate in gms. per 100 c.c. B	..	0·0428	0·0468	..	0·0483	..	..	..
Difference in sulphur between A and B, per cent.	..	18·6	15·1	..	13·0	..	..	..
Percentage of sulphur existing as sulphite in A	..	38·9	39·4	..	47·8	..	..	..
Nitric acid content of condensate, gms. per 100 c.c. A	..	..	0·0111	0·0137	0·0129	0·0090	0·0095	0·0090
Nitric acid content of condensate, gms. per 100 c.c. B	0·0050	0·0054	0·0043	..	0·0032	..	..	..
Loss of nitrous acid between A and B, per cent.	..	..	61·3	..	75·2	..	..	..
Copper in condensate, gms. per 100 c.c.	..	0·0699	0·0727	0·0645	0·0717	..	..	0·0094
Free acidity by titration, mg. equivalents per 100 c.c. A	..	..	1·54	1·27	1·46	..	..	..
Free acidity by titration, mg. equivalents per 100 c.c. B	..	..	0·79	..	0·98	..	−0·010	−0·016

comparable with those from the corrosion tubes were eventually obtained. In Table 13 results obtained with fresh and with stored condensate are marked A and B respectively, the numbers at the top of each column indicating the test numbers of Table 12 and their corresponding operating conditions.

It was clear that the above effects might arise from the atmospheric oxidation of cuprous copper, sulphites, nitrites, or by actual escape of sulphurous or nitrous acids. A number of distillation tests by the method outlined in the 33rd Report, p. 45, showed that sulphur dioxide could be readily expelled from fresh condensate, and that approximately 40 per cent. of the sulphur was in the form of sulphites, a fact of considerable interest. Exposure of the solution resulted in the loss of a small proportion of the sulphur dioxide, but Table 13 shows that the bulk was oxidized to sulphur trioxide and remained in the solution.

The escape of nitrous acid upon exposure was even more marked than the escape of sulphur dioxide, and reliable results for total nitrogen acids in the condensates from the combustion of town gas were obtainable only when the condensate was allowed to fall directly into hydrogen peroxide solution. With the stripped gas the change in permanganate consumption of the condensate was much less marked, and there was less likelihood of loss of nitrous acid, as the condensates were neutral or feebly alkaline. The nitrate content of the condensate from the stripped gas was, in fact, very similar to the maximum value obtained by dropping the condensate from the town gas directly into hydrogen peroxide solution, by which means the nitrogen acids could be fixed.

It would therefore seem unlikely that the sulphur acids interfere with the action of the nitrogen acids upon copper, or influence their solubility in the condensates (see present Report, p. 42, par. 6), but that the diminishing nitrogen-acid content of the condensates indicated by Figure 12 with increasing sulphur content of gas is caused by the escape of nitrous acid from solution in the necessarily prolonged period required for the collection of samples during the corrosion-tube experiments.

The existence of copper in the cuprous state to any noteworthy extent in the freshly collected condensate is uncertain, and while approximate relationships have been ascertained, a completely satisfactory concordance between the amounts of copper, sulphurous, sulphuric, nitrous, and nitric acids, and the permanganate consumption and free acidity of the condensates has not been established.

Communication No. 141—39th Report of the Joint Research Committee of the Institution and Leeds University. The Investigation of the Use of Oxygen and High Pressure in Complete Gasification—Part I. Gasification with Oxygen.

Dr. F. J. DENT, in reply, wrote: Most of Mr. Rhead's valued remarks call for no reply. He raised a query, however, regarding the reactivity of bituminous coals, and this is recognized as an important question to receive attention.

Dr. King appreciates the difficulies of gasifying coal with steam and oxygen under pressure on the laboratory scale. While it is agreed that results for the gasification of coal would be of interest, we feel that, at this early stage, laboratory experiments can well retain flexibility and wide application by being directed towards the separate study of the various reactions involved. With more knowledge of these, the course along which gasification and synthesis under pressure are likely to develop should become clearer.

Dr. King's suggestion to reduce the intensity of gasification by modifying the supply of steam and oxygen will receive careful consideration in our further work.

The apparent variation in the influence of the size of coke on the temperature of the fuel bed as observed at the Fuel Research Station and in the present experiments is probably due to the different conditions of gasification. At the Fuel Research Station, the fuel was gasified by the normal water gas process of intermittent blow and run. During the run, the reaction of the steam in the high temperature zone would not be hindered by the presence of free oxygen, and the greater reactivity of smaller coke would have full play in lowering the temperature of this zone. This would not be so when steam and oxygen were admitted together, as in our experiments. Then, it was found that the maximum temperatures in the fuel bed were higher the smaller the coke, and this we connect with there being less radiation in the coke column and, also, with a more complete mixing of the gases flowing through it. As Dr. King points out, the effect was only observed over a very shallow zone.

Dr. King's progress with gasification by steam and oxygen in the Vortex burner will be followed with interest. Handling fuel in the pulverized form has much to commend it and possibly may solve the problem of accommodating the caking properties of many of the coals available.

In spite of the coincidences noticed by Dr. Schuftan it is doubtful whether Meyer's investigation of the mechanism of the combustion of graphite can be applied to account for the temperatures developed during the gasification of a coke column. Meyer's observations were made on the primary reactions under conditions which intentionally avoided secondary reactions as far as possible. We believe, and indeed Meyer's experience confirms the view, that the mixing of the gases and the ensuing secondary reactions play an essential part in the gasification of a bed of fuel. When discussing the factors determining the temperatures developed in the fuel bed we had more than the primary reactions in mind. Mr. Hodsman's analogy with the oxidation of hydrogen sulphide in presence of hydrogen illustrates the type of mechanism which was imagined to be involved.

Mr. Hodsman outlines the development of gasification with oxygen as one who has been interested in the process since its inception. We are fortunate in having his advice and suggestions at Leeds in carrying out our experiments.

We are keeping in close touch with the investigations of Mr. Davis at the South Metropolitan Gas Company. The collaboration has already proved valuable and will undoubtedly become increasingly so as the work progresses.

Communication No. 142.—6th Report of the Liquor Effluents and Ammonia Committee.

Dr. A. KEY, in reply, wrote: Mr. Holton asks several questions regarding ammonium bicarbonate—questions which cannot be answered with certainty at the present stage of the Committee's investigations. There are two main aspects to be considered regarding ammonium bicarbonate: (1) Can it be used as a fertilizer as effectively as sulphate? (2) Can it be manufactured more cheaply than sulphate?

After briefly investigating the latter question and developing processes of manufacture which bid fair to reduce the cost of production to below that of sulphate, attention was given to the fertilizer aspect before proceeding to a quantitative study of the costs of manufacture. As a result the value and limitations of ammonium bicarbonate are now fairly clearly defined. One would hope, of course, for results to be obtained more quickly and more accurately, but agricultural experiments are by their very nature slow and only approximate. Investigation of a new fertilizer may take years and many trials may be ruined by some uncontrollable factors—rain, drought, inequalities in the soil, &c.

It is not intended to recommend that there should be a wholesale change-over from sulphate making to bicarbonate manufacture. When the Committee took up the subject it was felt that ammonium bicarbonate as a form in which ammonia might be recovered offered such prospects as to justify full investigation. Information accumulated as a result of this does not justify a general change-over of methods of ammonia recovery, but it does indicate that in the event of certain circumstances arising ammonium bicarbonate would be a useful alternative to sulphate and could be used as efficiently. It may be that in some cases these circumstances already exist.

The section of the Report dealing with the treatment of sewage-gas liquor mixtures by chemicals is not intended to suggest that further problems of liquor disposal lie in front of the Gas Industry. It is part of the policy of the Committee to keep in touch with the latest methods of sewage treatment, and recently great interest has been evinced in the possible use of chemical precipitants in this direction. To what extent these methods will be used in this country is uncertain, as Dr. Parker pointed out, but one of the factors which ought to be considered in this connection is the response of such a widespread trade waste as Gas Works liquor to such treatment. It is surely preferable that this should be determined before the adoption of the process rather than afterwards when the damage has been done.

The Report as a whole, I think, provides the answer to Dr. Monkhouse's question as to the relative ease of treatment of spent liquor containing fixed ammonia and spent liquor from which the fixed ammonia has been removed by lime. Any excess lime will have a precipitating effect on the sewage, but this should be very small, as such liquors should be freed from lime sludge before admittance to the sewers. The controlling factor will therefore be the ammonia content. The fixed ammonia in the unlimed liquor requires oxidation on bacteria beds; ammonia is absent from limed liquor and this should not therefore require so much treatment. At the same time colour production due to the use of lime may cause trouble, especially where the quality of the purified sewage is judged by its appearance rather than by chemical and biochemical tests.

It is pleasing to note that Mr. Holton has found such benefits from the installation of a detarring plant to act on the hot crude gas. The improvement effected by such treatment has been described in previous Reports and will be particularly appreciated where phenol recovery is practised and colour troubles experienced. It is a mistake to suppose, however, that such detarring plants are only available for large works, although no doubt the cost of treatment will be relatively greater for small undertakings.

Communication No. 143—27th Report of the Refractory Materials Joint Committee

Mr. A. T. GREEN, in reply, wrote: I thank Mr. West and Mr. Allen for their very interesting contributions to the discussion. I express my agreement with the manner in which Mr. West reviews the significance of the researches to the Gas Industry. Mr. Allen gives important data on the application of town gas to the firing of pottery ware, which must be useful to the Gas Industry. I shall bear in mind his suggestion that investigations on the effect of coal gas on the durability of silicon carbide refractory materials at temperatures above 800° C. would provide useful information.

Communication No. 145—The Institution Gas Research Fellowship Report; 1935-36. The Scaling of Mild Steel in Sulphur-Free and Sulphur-Containing Furnace Atmospheres (continued), by H. C. Millett, Ph.D., and J. W. Cobb, C.B.E.

Dr. J. C. HUDSON wrote: I have read the Report with very great interest and am glad to note that Professor Cobb has been able to resume with Dr. Millett the work on oxidation that he so worthily began with other collaborators some years ago. The present Report is another valuable contribution from the University of Leeds and may be said to increase our knowledge of the subject to a material extent. Perhaps the most welcome feature of this work is the quantitative way in which the effect of traces of impurities in combustion atmospheres is being elucidated; the confirmation in the anomaly in the oxidation temperature curve for mild steel in air between 800° and 900° C., as first reported by Portevin, Pretet, and Jolivet, is also of considerable fundamental importance.

The Authors have referred in their earlier Report to the review on the Oxidation and Scaling of Metals, published last year by the Department of Scientific and Industrial Research. In one section of that review, Mr. T. E. Rooney and I recalculated on a common basis the data available from all previous experiments on the oxidation of iron and steel in air or oxygen, as affected by temperature, and have been able to derive from the mean values two equations that give a reasonably good representation of the data. I have plotted in Figure A the values given by Dr. Millett and Professor Cobb in Table 8 of their present Report in the same units (in. of metal oxidized per hour) as those adopted by Mr. Rooney and myself, together with the values calculated from the second of the equations referred to—*i.e.*, $\log k = 4{\cdot}4944 - 04829/T$, where k is the oxidation rate in in. per hour and T the absolute temperature. It will be seen that the agreement between the Authors' results and the values calculated from the equation is very good indeed between 900° and 1,100° C. and there is no doubt therefore that either set of figures may be accepted as representing the oxidation rate of mild steel in air over this particular range of temperature.

It is fortunate that the Authors are to continue and extend their work and I have no doubt that their association with the Alloy Steel Research Committee of the Iron and Steel Institute will be a very happy and fruitful one. Since the work is to be continued, I would venture to make one or two suggestions for the Authors' consideration:

1. They no doubt appreciate as much as anyone that the value of the work would be materially increased if they were able to push their experimental range of temperature higher. They have now been able to work at 1,300° C. and another 50° or 100° C. would bring them well into the range of temperatures prevailing in re-heating furnaces as used for cogging and rolling in the steel industry.
2. The steel used by the Authors in their experiments was not truly a "mild steel"; its sulphur content, 0·17 per cent., was abnormal and in all probability it was so-called "free-cutting" steel. While it is possible that this type of steel is of especial interest to the Gas Industry, it would be preferable in a fundamental investigation such as this to use a material with a more normal sulphur content. Possible specimens of commercial ingot iron, preferably derived from the rim of the original ingot, might be the most suitable for the purpose.

Dr. H. T. ANGUS (Birmingham) wrote: In the practical

application of gas to industrial heating problems there have been serious gaps in our knowledge. The information required may be known, but it is not readily available, and it is for this reason that works such as the present are likely to prove of great assistance to the engineer who is anxious to improve his industrial loading.

Technical data regarding the properties and behaviour of unburnt gas are readily available, but information concerning the effect of products of combustion is still limited in amount, and still more difficult to trace, and it is satisfactory to observe that the Gas Industry is co-operating with the Iron and Steel Industry in an attempt to obtain a reliable basis of the fact to the difficult oxidation problems.

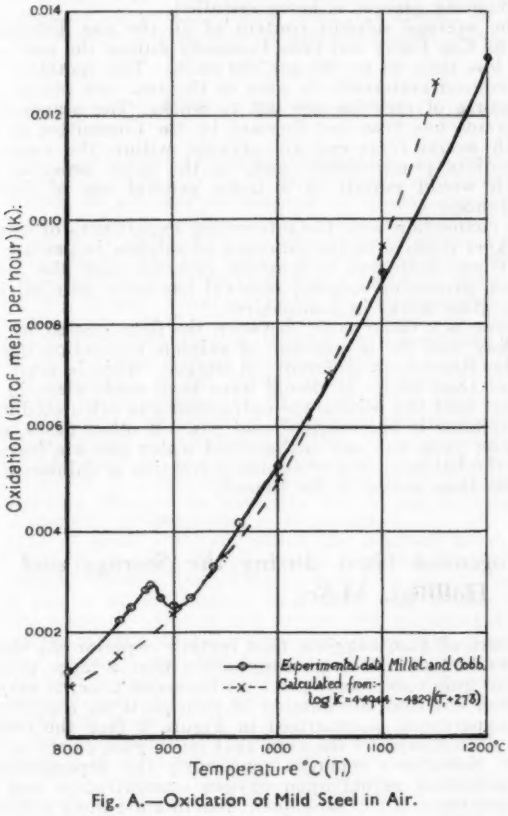


Fig. A.—Oxidation of Mild Steel in Air.

It is interesting to observe that nitric oxide does not materially affect scaling in the concentrations formed when burning gas.

The increase in scaling produced by sulphur dioxide is quite remarkable, the more so that it appears independent of the type of atmosphere, and increases with temperature much more rapidly than much larger additions of oxygen. Mr. Evans has suggested that the effect may be due to the formation of intermediate compounds such as sulphite or sulphate which decomposed, leaving a more porous form of oxide. The appearance of the oxide coating produced in sulphurous atmospheres, as described in the latest Report, would not appear to uphold this theory.

The melting point of iron sulphide (1,180° C.) is appreciably lower than that of the mixed oxides, which may be about 1,400° C., but the scales produced at 1,200°-1,300° C., as described, would appear to indicate that the lowered melting point might be one cause of increased permeability, particularly as at 1,300° C. with 0·2 per cent. SO_2 scaling appears to be proportional to time, indicating that the parabolic reduction of scaling rate due to solid diffusion has given way to another mechanism.

An investigation of the sulphide-oxide equilibrium diagram might possibly be of assistance in interpreting these results.

Written Reply.

Prof. Cobb, in reply, wrote: Dr. Millett and I wish to express our appreciation of the manner in which this Report has been received. It is gratifying to know that, as indicated by both Dr. Walter and Dr. Fells, close attention is being given at Birmingham and Sheffield to this important question of the action of gases on metals. We are in complete accord with Dr. Fells when he stresses the importance of investigating methods applicable in works practice to the securing and maintaining of the desired atmosphere in furnaces. In such matters the Industrial Gas Centres, suitably staffed and organized, could render a great service to the gas and metallurgical industries, and to other industries in which scientifically controlled heating operations play an important part. A complete answer to Dr. Fells' remarks concerning the propriety of using oxygen-enriched air for the purpose of working at temperatures of 1,300° C. is to be found in the contribution by Mr. Hodsman.

In pointing out the irregularity in the rate of oxidation between 850° C. and 930° C. to which Dr. Walter refers, we have not attempted explanation. Portevin and his collaborators conclude from their experimental results that it may be caused by a change in permeability in the oxide layer. They also point out that as this irregularity occurs at approximately 900° C. it may be due to the α to γ inversion of iron as Dr. Walter suggests.

It must be remembered, however, that in such a plain carbon steel as we used, the α to γ inversion does not occur at a definite temperature but over a range of temperature extending from 700° C. to a little below 900° C., and for this reason we find it difficult to understand how this irregularity can be due to the α to γ inversion. We may, however, point out that in our experiments hollow blisters began to form at 880°-890° C.; below this temperature the scales were quite smooth, above it rough but solid. Upthegrove and his collaborators have made similar observations and have made the reasonable suggestion that the discontinuities in the blistered scale were responsible for the checked rate of scaling.

The suggestion that Dr. Walter has to make that the resistance of the metal to attack by oxygen and sulphur dioxide is determined to some extent by the physical condition of the metal surface is one that we shall bear in mind. As regards the differences in behaviour between mild steel, high carbon and alloy steels, these are under investigation for the Alloy Steels Research Committee of the Iron and Steel Institute. The occasional protective effect exercised by sulphide films on steel has been brought to our notice recently.

We wish to thank Dr. Hudson for his written contribution to this discussion, and note with great interest the close parallelism between our results for the scaling in air and those calculated by him from the equation in which he had summarized the results of previous investigations. The importance of making experiments at still higher temperatures is realized, and work has already been commenced along those lines.

The sulphur content of the mild steel we used is admittedly higher than we should have wished, but in some experiments made in comparison with a lower sulphur steel no significant differences in result were forthcoming.

In the contribution by Dr. Angus we note with appreciation his written comments on the nature and constitution of the scale. Both are receiving further examination.

Communication No. 146—Report on the Removal of Sulphur Compounds from Town Gas Down to 10 Grains per 100 Cu.Ft.

Mr. C. S. Shapley (Leeds) wrote: In the discussion I was interested in the remarks of Mr. Evans and Mr. Bloor that sulphur in gas was responsible for "bloom" on glassware when town gas containing sulphur was used in the process. In view of these statements, it would be of interest to relate an experience we had with regard to "bloom" on electric light bulbs which were being processed with town gas.

A manufacturer had this trouble and called in an expert on glass technology; his advice was that the sulphur in the town gas was responsible and suggested cutting out town gas and adopting producer gas. The manufacturer informed us of his problem and also the suggested remedy and we decided to investigate matters.

In the investigation, the "bloom" on the glass was subject to qualitative micro-analysis, also the processing of the glass was carried out with gas free from organic sulphur compounds and the results noted. The sulphur was totally eliminated from the gas by being passed through an active carbon filter capable of stripping more than five times the amount of gas used in the experiment. The micro-analysis showed that the "bloom" was princi-

pally salts of sodium and potassium carbonates and sulphates, and in all probability had been formed by an initial condensation of moisture dissolving some of the glass surface which on evaporation left crystals which appeared as a bluish " bloom " on the surface of the glass.

The bulbs were of " lead " glass but no trace of lead was found in the " bloom " deposits, and it is suggested that the glass has a surface layer indistinguishable to the eye, but differing in composition from the main body of the glass, and this layer is soluble in water. Confirmatory experiments tended to prove this theory correct.

In the experiments on processing the glass with the sulphur-free gas, we found that " bloom " was still formed.

From the above and other experiments carried out we came to the conclusion that *moisture and not sulphur* was the cause of " bloom," and where initial condensation was prevented by raising the temperature of the glass above the dew point of the products of combustion of the gas before commencing the processing operations, it was possible to avoid the formation of " bloom " on the glass.

We were able to " bloom " a bulb without bringing it into contact with gas at all, by simply passing it quickly over steam and drying out in a steam oven.

On examining the advice given by the glass expert that the substitution of producer gas for town gas had in many earlier cases proved a remedy for " bloom " troubles, we came to the conclusion, in complete disagreement with the glass expert, that the sulphur content of the gas was of minor importance, the major factor being the difference in the dew points of the products of combustion of producer and town gas which are approximately 97° F. and 140° F. respectively.

With producer gas it is improbable that any transitory condensation occurs during processing.

This experience has been put forward not to justify the presence of sulphur in town gas, but to show that, while sulphur in gas is undesirable, it should not on that account, without investigation, be held responsible for industrial troubles.

In the case quoted, we should have lost a very large gas consumption had we accepted the expert's ruling without a thorough investigation on our own account.

Written Reply.

Mr. H. HOLLINGS (Gas Light and Coke Company), in reply, wrote: Dr. Hartley makes a strong plea for gas of a still lower sulphur content and states the limitation in the use of gas containing 20 grains of sulphur per 100 cu.ft. in flueless appliances. It was the recognition of this limitation which led to the work outlined in this Report. The active carbon process has been working at Harrow since 1928, and at Beckton since 1932. At the present time a plant is under construction at Bromley, while at another Works of the Gas Light and Coke Company the modified oil washing process is being installed.

The average sulphur content of all the gas distributed by the Gas Light and Coke Company during the past year was less than 16 grains per 100 cu.ft. This quantity will be reduced materially as soon as the two new plants now in course of erection are put to work. The standard of 10 grains has been put forward by the Committee as one which would represent an advance within the range of immediate practicability and, at the same time, as one which would permit of a more general use of flueless appliances.

In connection with the interesting experiences of several speakers relative to the influence of sulphur in gas used in the Glass Industry, it may be recalled that the active carbon process of sulphur removal has been installed in a large glass works in Lancashire.

There is a discrepancy between the data quoted by Mr. Mackay and the percentage of sulphur extraction quoted in the Report for different oil usages. This is more apparent than real. It should have been made clear in the Report that the percentage extraction was calculated upon the sulphur in the original *coal* gas. If other gases, such as coke oven gas and carburetted water gas are brought into the balance the *percentage* extraction of sulphur must be less than stated in the Report.

Communication No. 147.—The Formation of Nitrogenous Gum during the Storage and Distribution of Gas, by H. Hollings, M.Sc.

Dr. M. W. TRAVERS (Bristol) wrote: Regarding the effect of nitric oxide in promoting gum formation, it is suggested that nitric oxide is formed during the carbonization of coal, and that this compound is the cause of the formation of gum on the leathers of gas meters and elsewhere in gas apparatus. There seem to me to be one or two difficulties in the way of accepting this statement as it stands, and the following suggestions may be helpful.

It is difficult to see how the nitric oxide remains free in the gas which contains a little oxygen, for it would be converted rapidly into the dioxide, NO_2. This substance, in presence of NO, and of a compound containing an $-CH_2OH$ group would form the nitrite $-CH_2NO_2$, this reaction being well known, and taking place with very remarkable rapidity if the alcohol is in the liquid phase. I have recently been studying the thermal decomposition of the nitrites. They decompose giving two sets of products:

$$2\,R.NO_2 \rightarrow 2NO + R\text{-}CHO + R\text{-}CH_2OH, \text{ or}$$
$$N_2O + 2\,R\text{-}CHO + H_2O.$$

Thus the nitrite is regenerated again, but aldehydes are also formed.

Now it is well known that aldehydes undergo condensation very easily by themselves, and even more easily with such compounds as phenols. I suggest, therefore, that while nitric oxide may be the cause of the trouble, the mechanism is that set down above, and that the aldehydes are the compounds which form the condensation products. This explains why the gas can travel for a long distance before the gums are deposited.

The alkyl nitrites are very peculiar substances, and are not normal esters. They are very difficult to hydrolyze.

Written Reply.

Mr. H. HOLLINGS (Gas Light and Coke Company), in reply, wrote: I quite agree with Sir Gilbert Morgan and Dr. Schuftan that the formation of the diolefine peroxide has not been demonstrated experimentally. The diolefine-oxygen-nitric oxide complex is also hypothetical, but the hypothesis fits the known facts and it is perhaps not without significance that conjugated diolefines are the only hydrocarbons which accelerate the elimination of nitric oxide from gas. I have not succeeded in producing a catalytic effect with volatile iron compounds as described by Dr. Schuftan.

Professor Whytlaw-Gray's calculation of the vapour pressure of gum suggests that further experiments should be conducted to test his supposition that a large proportion of gum exists as a gas. At the same time, it may be pointed out that the number of gum particles recorded in the experiment summarized in Figure 8 (see the broken line) do not support the view that much gum exists as gas.

Dr. Schuftan's remarks concerning the dependence of the induction period upon oxygen concentration and the independence of the subsequent reaction are most welcome. They clarify what might have been expressed more clearly in the Summary of the Paper.

Mr. Marsden has had an opportunity of correlating the disappearance of nitric oxide in mains with the velocity of gas flow. His observations appear to explain the differences between experiences at Bristol and at Brighton.

Dr. Travers puts forward an entirely new hypothesis which will be studied with great interest by all workers upon this problem. I am not aware that there is any evidence of the occurrence of alcohols in purified coal gas, but, at the same time, I am very conscious of the limitations imposed by the absence of methods of analysis applicable to the very low concentrations of reactants with which we are now concerned. Furthermore, if the gums which have been examined during the present investigation have been formed by the condensation of aldehydes, it is very difficult to account for the presence of so much nitrogen in them.

Dr. Schuftan postulates the formation of an intermediate product, NO_3, in the nitric oxide oxidation. This opens the way to a modified explanation of the mechanism of gum formation which must be considered when his experimental results are published.

Mr. Cross has observed the beneficial effect of carburetted water gas. I believe this is due to the influence of the diolefines in causing gum formation, with the disappearance of the available nitric oxide, at an early stage while there is still time for gum precipitation before the gas passes to the district. I cannot accept Dr. Schuftan's alternative explanation because of the frequently observed inertness of blue water gas.

Gum Characteristics.

Mr. Marsden has examined different types of gum and he makes the interesting suggestion that a deposit of one type may act as a key for particles of another type. As a result of information which has come to light since this

Paper was written, it appears that much more research is needed upon the characteristics of gum. A more detailed knowledge of physical characteristics may lead to the perfection of some process of gum removal, such as that described by Mr. Hudson.

I cannot remove the obscurity surrounding the theory of the process used in the estimation of nitric oxide to which Sir Gilbert Morgan refers, but in view of the importance which attaches to a knowledge of the nitric oxide concentration throughout any investigation concerning gum, I would like to state that the empirical factor of 3 has been confirmed in several hundreds of tests made upon synthetic mixtures. It may be, however, that under certain circumstances nascent gum will react with the Griess reagent.

Mr. Henshaw and Mr. Hudson question the wisdom of admitting steam to the holder inlet. It should be emphasized that it is proposed to use steam only when the dew point of the gas is below atmospheric temperature. In many cases this will only be during hot weather. Furthermore the quantity used is only equivalent to the quantity of water vapour which would be taken up by the gas if the gas were passed through a washer fed with warm water.

Mr. Cooper refers to a marked decrease in the number of complaints received by the Gas Light and Coke Company early in 1935. I believe that this was due to an improvement in storage conditions which occurred at one of the larger works in 1934.

During hot weather some nitric oxide is evolved from oxide of iron purifiers and also, when steam is not used, the storage conditions are less favourable for the precipitation of gum. It appears to be natural, therefore, that there should be more gum in the gas in the summer than in the winter, but it is also natural that there should be a lag in the receipt of complaints.

Communication No. 148—Small Gas Governors, by H. J. Hadow, B.A., and L. H. Pinkess, B.Sc.

Mr. E. E. Jeavons (Birmingham) wrote: The observations I have to make on the Authors' excellent Paper will be confined to pressure as opposed to volume governors, and to experience on both high and low pressure governors.

In Section II (Introduction), the Authors of the Paper correctly claim that the fixing of gas governors effects many savings and increases efficiency. Although some Engineers fit service governors only, it is becoming increasingly clear that in most cases (particularly where there is H.P. distribution or boosting in operation) both service and point governors should be fitted if a high standard of efficiency at the burner point is desired. After all, the end to be achieved by fitting small governors is to obtain maximum efficiency of appliances, particularly at the burner point. To succeed in this, it is necessary to control the rate of gas input, and the most important control factor is "pressure," which should be constantly maintained. Hence the necessity for fitting governors, and, I suggest, for governing in two stages.

A type of small governor which the Authors have not dealt with is the dual-purpose type required for service on a supply which is part time operated at high pressure (when gas is being boosted) and part time at low (or district) pressure. But in the design and manufacture of these there is little departure from ordinary high-pressure governor practice, and the Authors' investigations can be held to cover these governors. The main difference is that greater valve area is necessary to pass the required volume at low pressure.

The Authors having dealt almost exhaustively with the performance of low-pressure gas governors, one finds little to add which would be helpful. Therefore, it would perhaps be well to turn next to Section III (8) on the Practical Considerations in Design and Manufacture. One must entirely agree that the semi-chrome tanned East Indian sheepskin is best for governor diaphragms, and also that binding washers—say, of flaxboard—which are essential for small point governors, are also necessary on many types of service governors in order to maintain a constant effective diaphragm area.

With regard to diaphragm dressings a good deal might be said. It is a subject of wide interest, and as far as my experience goes no single material has shown up better than any other. It can be said definitely, however, that high viscosities tend to keep the oil in the leather longer than do low viscosities and a stiffening medium such as cod oil cannot be otherwise than beneficial. If there were any danger of the latter becoming rancid, the addition of one part of an antiseptic in 1,000 parts of the mixture would prevent the tendency to turn acid, and avoid damage to metal parts of the governor.

A point worth noting in connection with valves for high inlet pressures (on service governors) is that rubber is generally preferable to leather (although as the Authors say both are good) because:

1. The leather tends to porosity which leads to such troubles as poor "lock up" or "creep."
2. Rubber is resilient and non-porous and recovers its shape immediately after being pressed against the seat.

Satisfactory rubber valve material can now be obtained which does not swell appreciably in gas and withstands severe tests.

"Chattering."

I would like to add a few observations on the subject of "chattering" (pulsation). Pulsations are more frequent in dead weight governors, and this is due to the space above the diaphragm which is necessary to accommodate the weights and to allow for working movement. Once a periodic pulsation, or swinging, has started, the momentum of the weight type tends to increase and maintain the pulsations. Generally speaking, spring loaded diaphragms give less trouble in this respect, at all events in H.P. service regulators.

The Authors have not dealt at length with the question of compensating H.P. governors. In Germany and America, gas engineers have paid much attention to this feature, and one feels sure it will not be without interest and usefulness here. A certain method of compensating H.P. governors recently patented in this country gives excellent results. It is known as an "Ejector" regulator. A number (nearly 50) have been made here under licence and fitted with success. The principle adopted is to streamline the gas flow as it leaves the valve seat and enters the outlet pipe, so that no turbulence around the valve chamber or under the diaphragm can take place, and thus cause pressure drop on the outlet. Instead of a drop in outlet pressure, the flow being streamlined by an ejector ring mounted round the valve seat, travels at a greater velocity towards the service pipe and produces a venturi-like effect which causes an automatic pressure rise in the outlet pipe as the volume passing increases. This effect is dissipated along the carcase piping and at zero gas rate "locks up" or "shuts off" at a normal pressure of about 4 or 5 in. Although dissipated throughout the carcasing, increased volume and pressure of gas are always available when required by the appliances and most satisfactory working is obtained. This type of governor functions best when spring loaded.

Mr. R. N. LeFevre (Watson House) wrote: In their Introduction, the Authors have referred to the savings effected by the installation of a governor and how these may more than offset the first cost.

This fact, together with the elimination of the human element, is one of the most important phases of installation work, and constitutes the essence of the problem an undertaking has to face in determining its policy towards appliance governing. By "appliance governing" I refer to both service governors and appliance governors *per se*.

While district personnel may not be intimately concerned with the theoretical principles underlying governor design the fact remains they must possess a sufficiently adequate knowledge of the subject to be able fully to appreciate:

(*a*) When to fit a governor.
(*b*) *Where* to fit a governor should one be necessary.
(*c*) How to fit it.
(*d*) The many advantages accruing from its installation.

Time does not permit of reference to the first three points, but I have dealt with them in considerable detail elsewhere. I would, however, stress the need for the education of district personnel in this respect. So much harm can be done to the cause of governing through an imperfect knowledge of governor installation.

My fourth point (*d*)—the advantage to be gained—will be apparent from the following typical example of the result of governing an instantaneous water heater.

A suitable and reliable appliance governor—size ¾ in.—may be obtained at a cost of approximately 6s. This cost may sometimes be recoverable if the governor be fitted integral with the appliance. Even if the first cost be not recovered it is more than offset by the following advantages:

(1) Considerably reduced time for installation since the fitter has only to verify the operating pressure with

his gauge instead of lengthy observations of the meter dial with trial and error adjustments. The latter assuming he has a watch with a second hand and has reached S$_1$ standard in arithmetic!

(2) Errors of judgment on the part of the fitter are entirely eliminated.

(3) Customer satisfaction is ensured by a constant temperature rise of heated water.

(4) Maintenance service costs are reduced by
(*a*) less frequent inspections;
(*b*) less time per inspection;
due to the removal of the principal cause—excessive gas rate—of most service complaints and defects.

(5) Safety.—Mr. Masterman, at the Summer Meeting, dealt clearly with this aspect of the subject. Analysis of contributory causes of hazardous conditions will reveal that such few accidents as have occurred may be attributed primarily to excessive gas rate and only secondarily to faulty flue equipment and other contingencies.

The bird's nest in the flue terminal is of no serious consequence if the gas rate be correct and a proper baffler be fitted.

Ingenuity and Simplicity.

Mr. A. FORSHAW wrote: I should like to add my congratulations to those already expressed by previous speakers, on the usefulness of this Paper and on the application that must have been given to it. The Paper is most opportune. Although the appliance and its uses are well-known to all "gasmen," experience leads me to think that with the great majority it remains buried in their sub-conscious minds.

I have mentioned in another place the remark made by someone of scientific training. This is very much to the point and will bear repetition. He said: "When I first became acquainted with the Gas Industry I was greatly struck not only by the ingenuity and simplicity of the gas governor, but by its general applicability for domestic and industrial use. Since that time, however, I have gradually been forced to the conclusion that, in domestic practice at any rate, the gas governor is conspicuous by its absence." As a matter of fact, founded on wide observation, I think the Gas Industry, on its selling side, needs to become more governor-minded. It may savour of "bringing coals to Newcastle" to mention even briefly some of the reasons that make governors necessary in domestic practice, but I will take the risk. The seasonal and diurnal fluctuation of demand make it necessary to vary the pressure of supply at the works in order that those who are placed at the further limits of the district shall be adequately supplied. This results in periods of lower, periods of higher, and periods of rising or falling pressure. It is clear that, if the user at a distance is to be kept adequately supplied, it will entail wide fluctuation in pressure between the works and the distant one. My own experience includes a place where at dinner time on Sunday the pressure in the main leaving the works was 24 in. in order to give 2 in. at the extreme and some two or three miles distant.

This general necessity for varying the pressure appears to have become more pressing lately, first because of the increase in the number of houses and, not less, because of the increase in the consumption per house. These increases have often outstripped the immediate possibilities of enlarging the mains. Raising the pressure there has in many places been the only way of keeping users supplied at all. In these circumstances then, which with the best will in the world are outside the immediate control of the distribution engineer, the householder has now more than ever to make use of a gas supply that varies within noticeable limits. In the result the provision of a gas governor will give him more benefit than ever.

When a gas appliance is installed it is set by the fitter, to the extent of his knowledge, to give the best results at the pressure then obtaining. At any other pressure the results will be different.

So far I have only mentioned the effect of *varying* pressure, really with reference to its effect on the consumption and efficiency of gas appliances. There is another side to modern gas distribution to deal with which calls for a governor. I refer to the consistent tendency to adopt higher minimum pressures of supply irrespective of variations. This tendency has certain results. The higher the pressure the easier it is to ensure adequate aeration of Bunsen flames, but the noisier is the appliance. Again, the higher the pressure the higher are the gas bills likely to be, for the tendency is to take advantage of the pressure to get hotter fires, quicker boiling, &c.; and although convenience and effectiveness may be served it is usually at some expense in efficiency.

All these arguments in favour of a governor (which I have only used in an abbreviated form) led my firm to introduce one several years ago. It was designed for use with our domestic appliances (excluding geysers, which require something bigger); its performance was adequate for the purpose, while it was inexpensive.

Now here is the crux of the matter, here is where the wouldbe benefactor meets his check (and not spelt with a "que" either!)—it could only be supplied as an extra, and, of course, at a charge additional to that of the appliance. In these circumstances the "Maintrol" governor did not sell.

This is a matter in which the Gas Industry can help itself—viz., by insisting on having gas appliances fitted with governors. The Gas Light and Coke Company, as Messrs. Hadow & Pinkess tell us, has supplied some 300,000 appliances with governors. Any other Undertaking has it in its own hands to make use of this simple and valuable device by making its inclusion *at an inclusive price* a *sine qua non* with all appliances sold. After all, it is the gas undertakings' responsibility to advise and guide the consumer, and it is unnatural to expect the consumer to find out for himself the merits of a governor and to insist on having one at an extra cost, if the gas undertaking itself omits to include it.

Mr. C. A. MASTERMAN (Watson House) wrote: This Research Meeting of the Institution has concerned itself with several aspects of gas quality, the combustion characteristics of which have become subject matter for review by Institution research. At first sight, it may not be clear that the use of governors has any connection with gas quality and that their usefulness in that direction is therefore non-existent. This is far from true.

The recent demand for coke has, of course, influenced gas manufacture operations in the direction of diminishing the use of water gas plant and so reducing specific gravity. Adjustable gas appliances installed on the district at the present time will be set to operate correctly on the quality of gas now being sent out. Reversal of the coke demand or emergency demand for gas on the district will increase manufacture of water gas, and appliances as now set for low specific gravity and associated flame velocity characteristics will be liable to light back.

There is room for the development of a more stable burner than we have at the present time, but pending this development the abolition of manual adjustments of appliances and the introduction of automatic adjustment by means of a governor means that the appliance is automatically set for an average gas quality and requires to accommodate only half the degree of change which it is called upon to accommodate if by hand adjustment it is set at an existing low extreme, as is inevitable, and later the higher extreme is realized.

For this and for the other reasons set out in the Paper there is every expectation that the use of small governors will increase, and it is overdue that we consider what performance we require and give the makers every assistance to keep down their cost.

Authors' Written Reply.

The AUTHORS wrote: In reply to Mr. Chandler, we did not intend to give the impression that either point governors or service governors were generally preferable. There are many factors to be taken into consideration when making the choice, and although service governing has much to commend it, the use of point governors, the cost of which can be covered in the first cost of the appliance, is often a more convenient method of introduction.

The combination of governor and meter is interesting, but in the small high capacity meters recently standardized by the Institution there is little space within the casing to accommodate a governor.

We are very pleased to have Mr. Chandler's experience with the piston type of governor.

Mr. Benton has given in full the formula for calculating the performance of a diaphragm in which the leather is in the form of a circular arc. As, however, the actual curvature of the leather is not at all uniform, the actual performance departs from that calculated, in the way shown in Figure 16. The alternative formula which we have put forward is also based on inaccurate assumptions, but it is at present sufficiently accurate and is comparatively simple arithmetically. Further experience may eventually indicate a more satisfactory formula.

A governor is often an integral part of an appliance and the performances of the two are mutually related. It is therefore not advisable to leave the governor an indefinite period without attention. On the other hand, Mr. Lake asks why we do not provide for the breakdown of the governor. The governor is only of value if it can

be assumed a reliable control. He also suggests that the 25 per cent. heat input overload might be reduced. This is inadvisable since the accumulated variations due to calorific value, extent of drying of the gas, specific gravity, atmospheric pressure, and temperature, the size of the burner orifice, and the small variation in the pressure thrown by the governor may result in such an overload. A margin should, moreover, be allowed for manufacturing error and for deterioration of the appliance in use. The appliance should therefore accommodate it.

Mr. Masterman has emphasized, in his contribution to the discussion, that attention is due to the question of gas quality.

We are glad to have Colonel Peebles' emphasis on our contention for the standardization of governors. We agree that "specified value" would be an improvement on "standard value" in Section 2 (iii). The experience in decreasing the size of the vent hole is interesting and is in accordance with the resonance theory of the phenomenon.

We agree with Mr. Jeavons on the desirability of governing in two stages on high-pressure areas when the present inexpensive types of high-pressure governors are used since the variation of outlet pressure under not abnormal conditions may be as much as ± 1·0 in. The opinion of a manufacturer in favour of the binding of the edges of diaphragms for service governors is welcomed. In view of our limited experience with spring loaded high-pressure governors we find Mr. Jeavons' observations on chattering very interesting. The ejector type of regulator will give increasing pressure at high gas rates, but we have yet to be convinced that they will give accurately predictable results. The ejector action, of course, cannot have any effect at the "lock up" position, and is in itself quite independent of the actual form of loading used.

We are glad to have Mr. Crawshaw's additional emphasis on standardization. We thank him also for pointing out two errors. P in equation (3), page 11, should have been defined as pressure difference. There was an unfortunate misprint on page 16 which made the allowance for diaphragm irregularities in large governors ± 0·5 in. This should have read ± 0·05 in. We have no data to show that leather diaphragms behave differently in saturated gas and gas dried to the normal extent. In small governors, the grain is not left on the leather, and in large governors the leather is sufficiently thick to retain adequate dressing for a long time, whichever side is exposed to the gas. The exact dimensions of the former for a diaphragm are determined by trial and error.

We are glad to have comments on the value of governing gas supplies, and see that Mr. Forshaw is concerned over the financing of their introduction. We have emphasized that the first cost is offset by advantages which ultimately give a direct monetary return to gas concern and to appliance manufacturer. The spreading of the cost of the governor therefore becomes a matter of compromise.

We are glad to have set out in greater emphasis by Mr. LeFevre some of the advantages to be gained from governing the gas supply. We would mention the fact that if a service governor is attached to the inlet of the meter revenue is recovered to the extent of 0·5 per cent. for every 2 in. lowering of the pressure at which the gas is metered.

Communication No. 149—An Integrating Method for the Measurement of the Total Radiation emitted by Domestic Heaters, by A. R. Bennett, M.Sc., and Harold Hartley, D.Sc.

Mr. A. FORSHAW wrote: It is stated on p. 5 that the Leeds method is based on work carried out by Dr. E. W. Smith. In the interests of historical accuracy, and speaking as one who was present during the period of gestation, I am bound to point out that the person immediately responsible for the method was the first Research Chemist to the Joint Committee. I refer to Dr. Julien Drugman.

When Mr. Smith, as he then was, took over, the fundamentals of the method had been settled—viz., the use of the R.H.S. radiometer, the Rubens pile, and the cosine correction. He inherited what was a laboratory research method, and in characteristic fashion turned it into a practical appliance fit for use in a works laboratory.

Incidentally Dr. Drugman during the course of his work made some investigations on the iodine pentoxide method of CO determination and made improvements in the Gas Referees' sulphur apparatus—facts which, along with that already stated on the Leeds method, are apt to be forgotten with the passage of time.

The chief point of criticism I would raise about Messrs. Bennett and Hartley's method has already been mentioned by Dr. Fishenden—viz., that it can make no provision for ascertaining the distribution of the radiant energy about the surface of the hemisphere. In comparing different sources of energy this is surely a notable defect and one from which the rival methods are free. For this reason alone it does not seem likely to supersede entirely the use of the bolometer and thermopile.

The next point I would mention was also dealt with by another speaker—viz., that the bolometer and the Moll may be calibrated against a primary standard, which is not the case with the reversible block. The same criticism can be directed against its parent, the original Richmond block, which also depends on a number of assumptions as to absorption by the surface, specific heat of the metal, and flow of heat through the block to the thermometer. The first of these was also mentioned by Capt. Blackie.

Whatever may be the reason, it is a fact that fires tested by the Richmond radiometer and now by the integrating method invariably appear to give higher results than when any other method is used, although from Table 1 we should expect the Richmond method to give results midway between those given by the bolometer and the Moll (unless, of course, the majority of readings of the latter come in the region below the "100" given them as datum, a figure which has an unspecified rating in K.C.U. per cu.ft.).

The Moll found an energetic champion in Mr. Andrew, and he anticipated anything I might have said under that head.

It has been customary to use a seven radiant fire for test purposes. So large a surface in comparison with that of the hemisphere has always seemed to me to make errors more possible. It is a fact that the larger the fire tested the higher is the figure obtained for the radiant efficiency. The increase in radiant efficiency realized of late years emphasizes this possibility, and I think the accuracy of any method would be enhanced if those concerned now agreed to use a smaller fire for their work. This would have the further advantages that the test room would be less disturbed by input of heat and/or products of combustion and not least that the conditions would be more comfortable for the operator.

In conclusion, I should like to add my word of congratulation to Messrs. Bennett and Hartley to those already uttered. Only those who have been through similar research can appreciate the very painstaking work they must have put into the preparation of this Paper.

Mr. JAMES W. WOOD (Research Chemist, Leeds) wrote: The thermopile has given, and continues to give, good service in gas fire testing, and as it is unlikely to be completely displaced by Dr. Hartley's new radiometer, a few words upon it may not be out of place. A considerable proportion of the defects of the thermopile are traceable to the fact that most models have been designed for spectroscopic work, and during gas fire testing they are subjected to far greater intensities of radiation than were ever intended. Attempts to increase sensitivity, also, have usually been in the direction of reducing the size and weight of the receiver to a minimum, with consequent fragility and loss of stability. Some eighteen years ago I saw in Dr. Hartley's laboratory at Warrington large water-jacketed thermopiles of very robust construction, specially designed for gas fire testing. Mr. Howarth and myself also designed a large and heavy pile to replace the small "surface thermopile" constructed for the Joint Research Committee by my predecessor, Mr. Harrison, and we should doubtless have developed the idea but for the marketing of the apparently satisfactory Moll pile, and the temporary discontinuation of gas fire testing by that Committee. Creep, and failure to retain calibration when compared with the block radiometer, are troubles which have only been experienced to a very limited extent.

The new instrument would seem to be ideal for the rapid construction of gas rate-radiant efficiency curves, while the shorter time required for the test materially reduces the difficulty of maintaining the fire in a steady condition. In this connection it would be interesting to have Dr. Hartley's opinion as to the minimum time which should elapse between making an adjustment to a fire and commencing a radiation measurement upon it.

Bearing in mind the fact that the new instrument is to receive the whole of the radiation from each part of the

fire in turn, instead of sampling it, it would be useful if Dr. Hartley could indicate in greater detail the means whereby the proper orientation of the radiometer is effected, and what steps are taken to ensure that there are neither gaps nor overlaps between the zones in successive traverses. When dealing with a source of radiation which is neither small nor symmetrical, the projection of the radiometer on to the hemisphere swept out by the hoop is not too well defined if the receiving surface at any point is far removed from that hemisphere. For this reason the vertical placing of the radiometer is theoretically inferior to the tangential, although Tables 1 and 2 show that in practice the results obtained with the radiometer in the two positions may not differ greatly.

Protection of the radiometer against adventitious radiation seems to have been well cared for, but it would be interesting to know whether convection, especially at high and low latitudes, introduces uncompensated errors of any importance. The absence of any window, or of a shield projecting from the face of the instrument, eliminates troubles associated with certain thermopiles.

The Authors' Reply.

The Authors, in reply, wrote: We wish first of all to thank those who have communicated their views on the subject matter of our Communication. With a view to condensing our reply, we have dealt with the points raised by the various speakers under the subjects to which they refer, and are thus not able always to make reference to the contributor of the comment.

In our Communication we were not concerned to give a complete discussion of this type of instrument, but merely to summarize as briefly as possible our experience with the particular examples in our possession. In view, however, of the numerous references to the Moll pile which have been made by various contributors, we felt it might be of interest in answering the questions raised to give in somewhat greater detail our reasons for regarding this instrument as unsuited for use as a radiometer for gas fire testing.

It was Mr. Hodsman who suggested a good many years ago that we should consider the use of a Moll micropile as a substitute for the Rubens thermopile in the Leeds method of test. It was found that the Moll pile is much better suited to the determination of the distribution factors in the Leeds method than were any of the instruments previously available. It is, however, most valuable where low intensities or short exposures are involved, but when it is subjected to intensities such as are encountered in gas fire testing, non-linear characteristics are exhibited in the results attained.

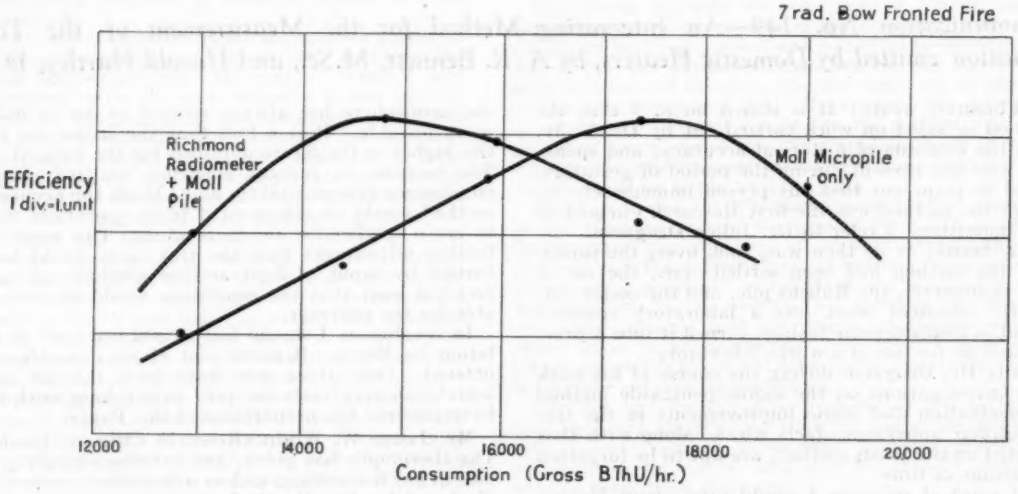
We have referred in our Communication to the results of a comparison between the Moll micropile and the Richmond radiometer over a range of intensities. Similar comparisons form part of all efficiency tests carried out by the full Leeds method, and our experience has shown that there is a marked correlation between the ratio

$$\frac{\text{Moll centre reading}}{\text{Radiometer reading}}$$

and intensity, the ratio increasing as the intensity increases at a rate in agreement with the results in Table 1 of our Communication.

Similarly there is a displacement of the position of the peak efficiency when the efficiency/consumption curve for a given source is plotted from results attained using first the radiometer-thermopile combination and second the micropile alone. This effect is illustrated in the accompanying diagram in which the Moll micropile calibration factor has been chosen to give the same value for the peak efficiency on both curves. The displacement of the maximum is in agreement with the view that the micropile reads high at high intensities. Again, in comparing the efficiencies of small and large sources of the same type the increase in efficiency with size is much more marked in the micropile test than in the case of the integrating radiometer. Our feeling is that the latter instrument will yield the more reliable results.

In two of the commercial forms of the Moll pile we have examined, there is a further defect which appears to have been generally overlooked. The sensitive elements are mounted at the end of a tube of approximately 4 mm. radius and 6 mm. long. Any radiating element of the source falling within the imaginary cylinder enclosed by producing this tube in space will irradiate the whole of these sensitive elements, but with radiation having its origin in a source outside this imaginary cylinder there will be a partial shadowing of the elements. For example, a point source 6 in. from the axis of the cylinder at a distance of 34·4 in. from the Moll micropile will irradiate only 92 per cent. of the receiving surface. For large sources this will result in a reduction by an indeterminate amount of the mean intensity on the receiving elements. We understand that when these instruments are standardized by accredited testing bodies the geometrical conditions of the calibration are always stated, and no responsibility is accepted for the accuracy of results attained under different conditions. The geometrical error due to this factor is, of course, quite independent of the geometrical errors introduced by the sampling method, of which Mr. Benton has also spoken.



With reference to the time lag which occurs in the use of thermopiles, in general an appreciable interval has to be allowed for the final "creep" to take place. Not only have the elements themselves to attain a state of thermal equilibrium with the surroundings, and this response may be rapid, but also it is necessary to ensure that the enclosing case shall have attained equilibrium. It is to be anticipated that a steady deflection will be attained when the micropile is left for a considerable time in front of a fire. If, however, the pile is then screened by a shield at room temperature it will be found that a negative zero is attained, usually amounting to 1 or 2 per cent. of the previous deflection. This negative reading immediately begins to diminish, and after half a minute or so a steady zero is established. In both calibration and use it is only legitimate to deal with steady readings and the speed of accurate working is not as high as is sometimes claimed.

We have given much thought to the question of using thermopiles of the quick-acting type since we drew attention many years ago to the disadvantages of the Rubens pile and attempted in the instrument referred to by Mr. Wood to attain an improved performance. The use of the thermopile in the measurement of radiation intensity de-

pends on the establishment of an equilibrium between the rate of reception of heat by the elements and the rate of loss from the elements by radiation, convection, and conduction. While conduction is a linear function of temperature excess, this is not the case for radiation and convection except over a limited temperature range, and then only as an approximation. The linearity of the scale will therefore depend on the dimensions of the sensitive elements in relation to the range of intensities to which the instrument is subjected. To attain rapidity of response the elements must be made as light as possible, and this tends to diminish the conduction component relative to the radiation and convection components. At the same time, liability to damage or accidental displacement due to vibration is increased. The temperature range covered by the thermo-electric elements of the micropile during tests of gas fires is some 5 to 6 times that covered by the integrating radiometer, so that the thermo-electric properties of the materials themselves are more likely to show variation in the former instrument than in the latter.

We are interested in Mr. Andrew's observations on the behaviour of the Moll micropile over a period of weeks, and feel he regards its behaviour as somewhat suspect over its first year of life. We find the integrating method to be more rapid and less subject to the "personal element" than are determinations based on the use of the micropile alone. With the integrating radiometer a single observer is able to attain a result in approximately half the time required to complete a determination and calculation when the Moll micropile alone is used, and 81 measurements are made as in the Leeds method.

As Mr. Benton has indicated, the theoretical analysis of the Leeds or other sampling methods is a matter of some difficulty and one which has not yet been investigated as fully as is desirable. We feel, however, that it can be shown conclusively that geometrical errors constitute a definite limitation to the accuracy of any method involving sampling, and that the mere multiplication of readings with an instrument such as the Moll micropile does not necessarily eliminate the errors. Both Mr. Benton's calculations and our own have suggested that the Russell-angle method when applied to most of the types of heat distribution encountered in practice is less accurate than is the original Leeds method of equal angles. In the majority of fires at present on the market the vertical distribution deviates more widely from the cosine law than does the horizontal distribution, and it is in such cases that the two methods are likely to show the greatest differences.

Alternative Methods of Total Radiation Measurement.

Dr. Fishenden has referred to the possibility of using a large hollow calorimeter which would surround the source of energy under test. This possibility has been considered, but it has been felt that the elimination of convection effects and the attainment of a true average temperature for the whole mass of the calorimeter would be matters of considerable difficulty. There is also to be considered the possible effect of the receiving surface on the flow of air to the source itself.

With reference to Dr. Fishenden's second alternative suggestion, the instrument referred to in footnote 5, page 5, of the Communication consisted of a series of thin silver plates blackened on one side and mounted in a water-cooled enclosure. The plates were arranged in two sets and were interconnected by thermocouples. Mr. Wood has also drawn attention to the development of Mr. Harrison's thermopile which we believe was of a similar type. We have been unable to find any published description of this instrument, and could not, therefore, make reference to it in our Communication.

Distribution.

Both Dr. Fishenden and Mr. Forshaw have criticized the integrating method on the ground that it does not give incidentally the distribution of energy over the test hemisphere. The vertical distribution is, of course, attained in the course of the ordinary test procedure, but if the horizontal distribution is also desired a series of exposures can be made with the instrument standing in suitable positions on the test hemisphere. The problem we had set ourselves to solve, however, was the devising of an accurate method for measuring the radiant heat emitted by domestic sources. The determination of the distribution factor in the Leeds method was incidental, and in any case intensity measurements at a distance of 3 ft. from a fire have no great practical significance, as similar measurements taken at, say, 6 ft. from the same fire may show the distribution to be entirely different. Mr. Wood has raised the question of the effect of the orientation and positioning of the radiometer on the results attained. Consideration shows that the accuracy of setting called for is not as high as is perhaps to be expected at first sight, since if the radiometer is displaced in the direction of a line of longitude on the test hemisphere, the error introduced depends on the intensity difference between the two ends of the radiometer and not on the absolute intensity itself. The semi-circular arc supporting the radiometer is constructed to a radial accuracy of 1 part in 500, and it is easy to set the radiometer to within $\pm\frac{1}{32}$ in. of its true angular position. The error involved in a displacement of this order is absolutely insignificant. The angular setting of the radiometer about its horizontal axis is determined by the engagement of a spring-loaded pin with holes accurately drilled in a plate attached to the supporting stirrup. This can be seen in Fig. 2, page 15, to the right of the radiometer itself. The agreement which has been attained between the vertical and tangential methods of working suggests that the arrangement we have adopted is sufficiently accurate for practical purposes.

Cooling Correction.

The design of radiometer which we use at present is such that the cooling correction is approximately 3 per cent. of a given temperature difference during a 40 second period. If in the course of an exposure of 40 seconds' duration the temperature difference between the blocks varies from 0 to a given value in an approximately symmetrical manner, the cooling will be $1\frac{1}{2}$ per cent. of the final increment. By adopting the method of reversal, the cooling error is reduced to about 1/50th of this value. Dr. Fishenden is correct in assuming that the elimination of the error is approximate, but the method has proved to be surprisingly elastic and the cases dealt with in the Appendix cover a wider range of conditions than is likely to be encountered in practice.

The equations put forward by Mr. Benton illustrate clearly the considerations which led to the adoption of the reversal method of cooling. In our earlier work we used the approximations. We decided, however, that the accuracy of the method in other than the simplest cases could be checked more satisfactorily by the use of the more exact equations. Also the knowledge thereby attained was of value in the final setting of the dimensions of the receiving elements. Mr. Benton, with his usual courtesy, has refrained from stating that his calculations show an error in the correction for cooling quoted on the second page of the Appendix. We have confirmed his estimate that the error is 0·03 per cent. and not 0·12 per cent., the evaluation of equation (9) giving

$$\frac{AI_o}{1{\cdot}5713\ H}.$$

We have not been able to detect disturbance due to the motion of the instrument through the air, and as the integrating method leads to the attainment of results somewhat higher than those yielded by the Leeds method of test it would seem that there can be no unforeseen loss of any magnitude. The temperature difference between the blocks and the surrounding air does not exceed 2°-3° C., so that convection effects are of a small order.

Calibration.

Mr. Andrew puts forward a method of calibration which is based on the radiant output of the fire, and this is not assessed directly, but is estimated after measurement of the calorific value, the flue loss, and the computation of wall losses from a lagged system. The result contains the errors of the three estimations, which may be additive. It is our view that in practice the measurement of the flue loss with a sufficient degree of accuracy cannot be ensured by the method indicated. It is difficult to assess accurately the temperature of a stream of gases moving through an enclosure at a different and non-uniform temperature, and there are also errors inherent in the gravimetric determination of the average CO_2 content of the products, its correlation with the carbon dioxide yielded on combustion of the gas, and the calculation therefrom of the flow of air and products through the system. We believe that the use of known physical constants in the case of an instrument with an absorbing surface of the type used in the block radiometer leads to the attainment of more accurate results. It seems to us significant that measurements of the radiation constant have been attempted by purely physical methods when the highest degree of accuracy has been desired.

With regard to the statement made by Mr. Forshaw, it appears to us that any method of calibration applicable to the bolometer or Moll pile is equally applicable to the integrating radiometer. Were we convinced that the establishment of a standard source is a simpler matter than the determination of the thermal constants of a block of copper

we should have employed the former method in our calibration.

Absorption Correction.

In making the necessary corrections for absorption we have used the results of the work of G. A. Shakespeare* as was done in developing the Richmond radiometer. The grooving we have employed has a 60° taper (total angle) and the coefficient of absorption of the surface probably exceeds 0·98. For our absolute calibrations, however, we rely on a comparison with the Richmond block radiometer as indicated in Section IV. (*b*) of the Communication. In this instrument the grooving is much deeper and the block is made to overlap the aperture in the case, and by this means an absorption correction is avoided.

Solid Fuel Appliances.

Capt. Blackie has referred to the difficulties encountered in the measurement of the total radiation from solid fuel fires owing to the variation with time of the intensity and distribution of the energy emitted. The integrating method will enable a representative summation of the energy emitted in all directions to be attained in a period not exceeding 40 seconds. This is accomplished by using a number of radiometers mounted vertically on the semi-circular arc and connected in series to a galvanometer of suitable sensitivity. Automatic recording of the results can, of course, be effected.

* Proc. Roy. Soc. (A) 1912, **86**, pp. 180–196.

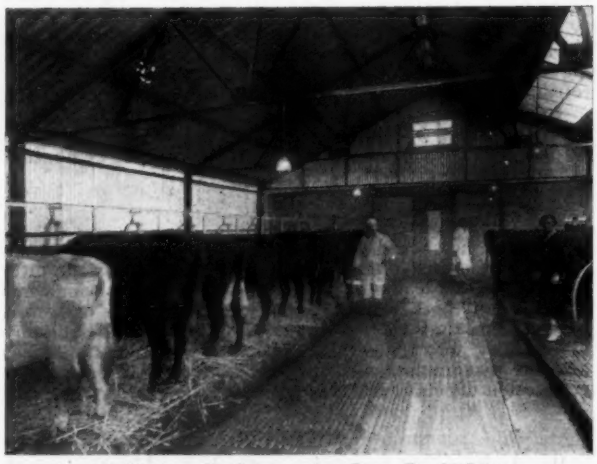
The standard scanning time of 40 seconds has been selected arbitrarily, and we believe this period could be reduced very materially without appreciably affecting the accuracy of the results. Our present feeling is, however, that there is little to be gained by a reduction in the time of scanning below the 40 second period we now use.

Comparison of Results by Different Methods.

Mr. Forshaw in his contribution to the discussion has stated that both the Richmond radiometer and the integrating radiometer invariably give higher results than other methods. Our experience in comparing the Richmond radiometer and the B.C.Y. bolometer does not confirm this, as the low absolute indications of the bolometer are counteracted by the fact that it yields a high value for the distribution factor in the case of sources having approximately cosine distribution. In such cases the efficiency results attained by the two methods are in good agreement. We have not attempted a calibration of the Moll micropile by any method other than comparison with the block radiometer, and, as has already been stated, the results attained using this instrument may be high or low, according as the intensity in the calibration experiment is low or high. The absolute value of the intensity which we have called 100 in Table 1 of our Communication was 143·6 B.Th.U./sq.ft./hr. as measured by the Richmond radiometer. This approximates to the average intensity normally encountered in tests of gas fires.

Applications of Calor Gas in Rural Areas

A Tour of Inspection



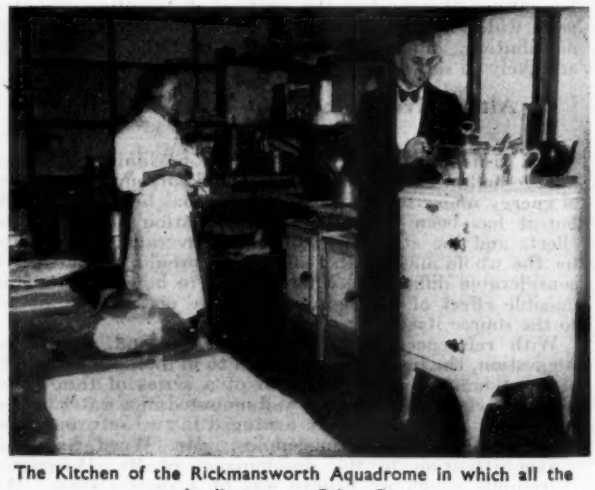
A Modern Cowhouse using Calor Gas Lighting.

To demonstrate the advantages of bottled gas for isolated rural areas, Calor Gas (Distributing) Company, Ltd., organized, on Tuesday of last week, a tour of inspection of different types of installations in Hertfordshire.

The places visited are situated outside the areas of normal gas supply, and consequently the inhabitants are unable to enjoy the convenience and comfort of a supply of town gas on tap. It is in such areas that Calor gas is capable of supplying a long-felt want; and first-hand evidence of its utility was furnished by the plants seen in operation.

Two striking examples of domestic installations were seen at King's Langley, where the cooking, heating, and lighting operations of a large modern residence and a farmhouse are satisfactorily carried out by Calor gas. Its application in industry was seen at the Cassiobridge Photograph Laboratory, where it is employed in connection with bunsen burners and boiling rings. At the Watford Bowling Club Calor gas is used in the pavilion for lighting and hot-water service.

A large-scale installation was inspected at the Aquadrome at Rickmansworth, where the entire culinary operations and the indoor and outdoor lighting are carried out by Calor gas. During the week-ends in the summer as many as three and four thousand people visit the place; and the flexibility of Calor gas is a great asset in meeting the peak demands. During the tour, also, some excellent examples of Calor gas street lighting and floodlighting were seen.



The Kitchen of the Rickmansworth Aquadrome in which all the Appliances use Calor Gas.

An instructive visit was paid to the fully equipped Calor Gas Company's showrooms in Watford. Here potential consumers are able to see all types of domestic appliances functioning on bottled gas, and full particulars in regard to the cost of operating each piece of apparatus are available. In addition to several showrooms, the Calor Gas (Distributing) Company, in furtherance of their campaign, are establishing throughout England and Wales a number of service stations and supply depôts ready to give a day-to-day guaranteed service to all users within their districts. Special agents have been appointed for Scotland and Ireland. The Company's organization includes a number of demonstration cars and mobile showrooms; and a central showroom will shortly be opened in London.

RECONSTRUCTION AT Stratford-on-Avon Gas-Works

by
F. SHEWRING,
(Engineer and Manager, Stratford-on-Avon Gas Department)

A Paper presented at the Autumn General Meeting of the Midland Association of Gas Engineers and Managers held at the Grand Hotel, Birmingham, on Thursday, Nov. 19.

It was in 1928 that I finally decided to provide a stand-by plant for taking coal to the top bunkers of Holmes-Winstanley vertical retorts. All the coal was then being handled by a hydraulic hoist, and although this was reliable and efficient the coal tonnage required was steadily increasing year by year.

Suitable plant and machinery for this class of work is somewhat costly. I was desirous of providing ahead and if possible installing plant which could readily be incorporated in any future carbonizing plant extensions.

After careful consideration a 30-cwt. steam hoist was installed, operated by a Sisson engine. This hoist now forms part of our Glover-West plant, it being only necessary to extend the height somewhat to meet all circumstances.

Each year the growth in business continued and I was faced with two alternatives—

(1) To enlarge, add to, or replace each section of plant as they became necessary on the existing site.
(2) To endeavour to purchase some adjoining land, install additional plant, and re-plan the works units on lines which would meet requirements for many years ahead.

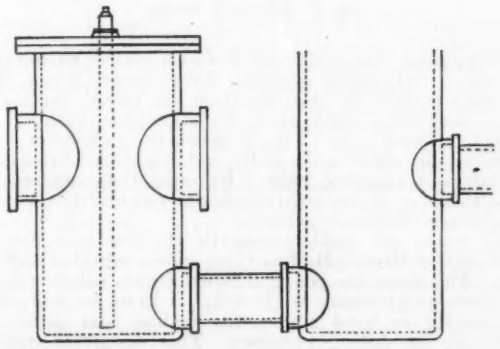
The latter proposition was decided upon by my Committee and I had instructions to proceed.

The land was acquired and the first section of extensions —comprising exhauster house and machinery, water-cooled condenser, washing units and building, gas heater, two new purifiers with steel framed covering, 15-in. gas mains, 6-in. tar main, 4-in. liquor mains, and a 3-in. steam main— was decided upon at an estimated cost of £5,500. The sum was to be provided out of revenue, and some of the existing plant was to be utilized when it was possible to release it.

A glance at the works' plan reveals the site as being long and narrow, not the most convenient shape for an ideal layout. Long lengths of gas mains, steam mains, and tar and liquor mains were necessary. Some care was initially required when planning these mains if future troubles were to be avoided. The site, however, has the advantage of railway sidings on one side, and a canal on the other. There are also wells of ample accommodation for tar and liquor.

After taking the levels it was found that there was very little fall from new site to the wells situate in the entrance yard of the works, a distance of roughly 270 yd. Experience has taught me that daily recurring work in the pumping of syphons can often be minimized or eliminated if due care is taken when first planning this class of work. I therefore decided to raise the level of site sufficiently to allow for a gravity fall from the tar and liquor collecting pot to the wells.

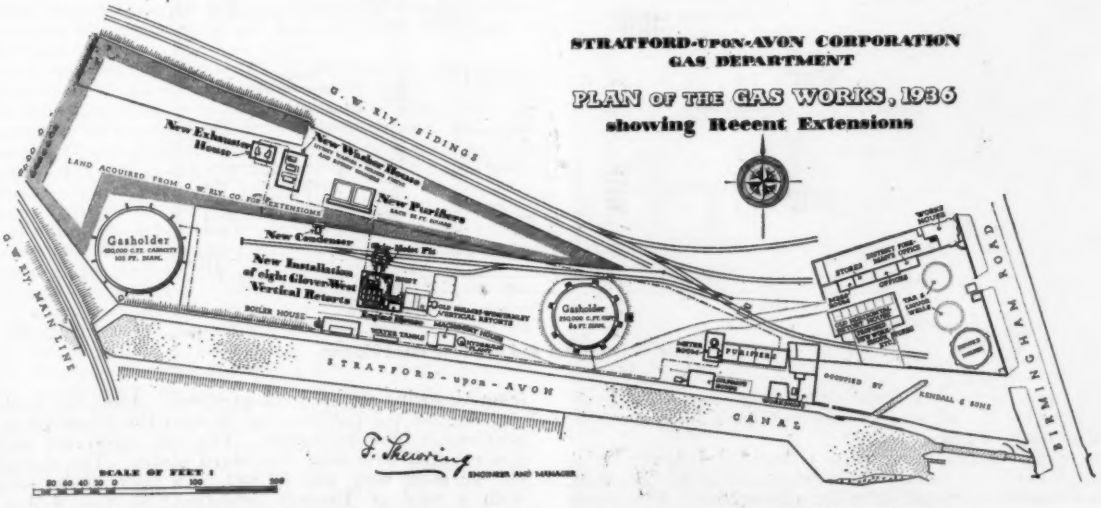
Syphon pots of the open type (see sketch) have obvious advantages and we adapted all syphons to this pattern. They can readily be made to operate as self-acting syphons. We have a syphon on outlet main of exhausters which automatically discharges the tar and liquor to a collecting pot which is at a higher level than the gas mains. I should have extended this arrangement to all syphons if the difference in levels between crude gas mains and tar wells would have permitted. A steam pump is coupled to pump all works' syphons if desired.



Sketch of Syphon Pot.

The first plant started upon was a new vertical type water-cooled condenser. The exterior is cast iron and the interior fitted with 480 mild steel tubes 6 ft. long by 2 in. exterior diameter. The tubes are grouped diagonally and laid in alternate directions, a central division plate being provided. The total cooling area is 1,506 sq.ft. The inlet and outlet water pipes are 4 in. diameter. Canal water is used, and the hot water is run to a water tank for boiler feed purposes. The contract price for the condenser was £355.

The levelling up of the site provided a convenient tip for the soil excavated from the various foundations. The gas and other mains were first laid, and the reduced depth of trenches contingent upon the raising of site, enabled this work to be done at a comparatively low cost. All foundations for these works were carried out by our own staff.



Plan of the Reconstructed Works of the Stratford-upon-Avon Corporation Gas Department.

The strata comprise heavy clay and marl. During the summer months if the dry, hot weather is prolonged the top clay develops cracks and fissures. At an excavated depth of 2 ft. the subsoil was found to be suitable for the concrete foundations required.

Fig. 1.—Exhauster House.

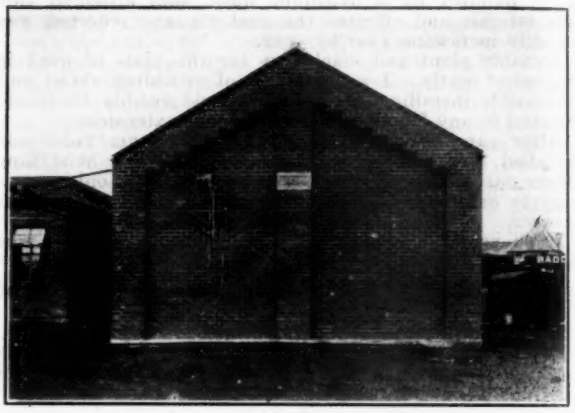
In designing the buildings I endeavoured to obtain a pleasing architectural outline. There seems to me scope for improvement in this direction on many engineering works, and this could often be attainable without any undue increased cost. Fig. 1 shows the exhauster house which is built with cavity walls, red sand-faced bricks, and a reinforced concrete roof. Between the concrete and asphalt a layer of insulating material was inserted, covered with Limner Trinidad asphalt.

The mains are hidden beneath the concrete floor on which is laid Minton-Hollins tiles, colour mingled buff and drab. The walls are rough finished cream colour cement. The doors and framing are in oak. A 15 in. by 5 in. rolled steel girder is fixed under the ceiling and above the machinery for lifting purposes. This design of building readily lends itself to enlargement by the addition of further panel sections without detracting from its appearance. The brickwork was carried out by a local contractor at a contract price of £229.

The 4 in. compensating pipe connected between inlet and outlet mains of exhausters is fixed outside the building with a suitable indicator valve for adjustment. The range of gauges are the "Sigma" diaphragm pattern which can be read easily at some distance away.

The exhausting plant is in duplicate, one set only being additional, and both machines are coupled to small exhausters for supplying air to the purifiers. We have a belt drive arrangement by which the percentage of air can be varied. Fig. 2 shows general layout plan of exhauster and washer houses. Previously the washing plant was scattered about in the open, so I decided to group it under cover. The building is a steel-framed structure encased with red sand-faced brickwork, of design similar to the sulphate of ammonia and boiler houses erected in 1921 and 1922. The roofing is composed of Turners Trafford tiles. The building was erected by our own staff.

The house contains Livesey washer, "Holmes" static washer, "Holmes" rotary washer, gas heater, and syphon pump. The size of mains throughout is 15 in. with the exception of some of the connections to plant which are 18 in.



Washer House.

Two purifiers each 25 ft. square by 6 ft. deep were installed with upward and downward gas flow. Provision was made to add additional boxes as required. The boxes are filled with one layer of oxide and the interior built up with layers of 2 in. square woodwork to prevent the oxide from throwing undue back-pressure. After the contractor had erected the purifiers we encased the whole of the connections in blue brickwork. The top, forming a platform, was covered with steel chequered plates. The contract for the purifiers only was £1,632. An open girder structure with a roof of Turners asbestos tiles was added upon completion.

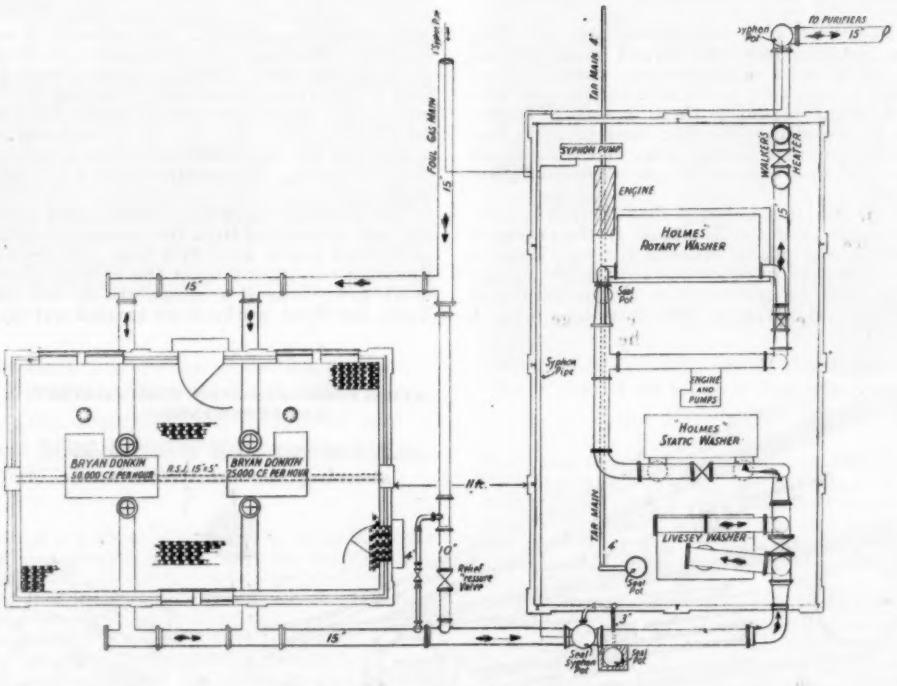
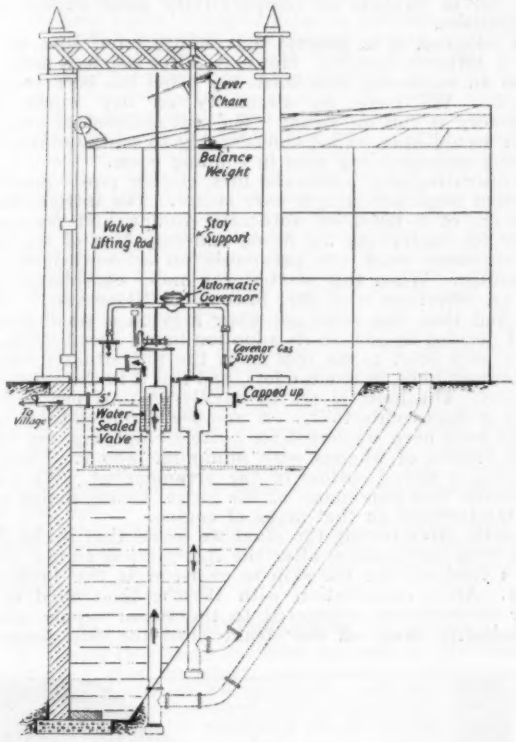


Fig. 2.—Plan of Exhauster and Washing Plant Houses.

The main steam supply is 3 in. diameter solid-drawn

flanged pipes, the flanges being electrically welded on. The lay-out entailed a long run of piping. I decided to carry them overhead on concrete pillars in preference to laying them underground. Overhead steam pipes are certainly unsightly, especially when they have to pass over



No. 3.

Diagrammatic Sketch Arrangement of Automatically Opening and Closing Gas Holder Valve.

railway lines at a height to comply with railway regulations, but the pipes and joints always being in sight receive better inspection and attention. Expansion bends and steam traps were provided and the whole was insulated and wrapped on completion. The reinforced concrete pillars we made on the site.

A District Problem.

It was at about this time that a problem on the district arose. We supply the village of Snitterfield, situate 4½ miles from our works. This village gas-works was privately owned and was coupled up with a 3-in. steel main to our nearest district mains in 1912. The pressure was sufficient to feed the holder.

There is only a single pipe line in the village and this pipe is continued to the gasholder. The main normally supplies the village with gas supplemented from the holder. The holder fills when little gas is being used, especially at night time.

About nine or ten years ago to supplement the Sunday cooking load we fixed a fan on the main about a mile out of Stratford-upon-Avon. The booster was then only run occasionally as required when the holder became low. The holder itself was getting in a somewhat bad state and the columns were out of alignment, and re-sheeting and other necessary repairs were put in hand.

About this period we had secured additional consumers on this main, the requirements of one being 1 million cu.ft. per quarter. This necessitated the regular running of the boosting plant, and a duplicate gas engine was added.

The problem was how automatically to shut off the gasholder when full, and to make the valve re-open to feed the village when the boosting plant was not working and when the pressure in the village became low. It is a simple matter to adopt the usual chain arrangement attached to the top of the holder, which closes the inlet valve when the holder rises to a predetermined height. This is all right when there are both inlet and outlet mains. The difficulty was the re-opening of valve, as the closing of the valve shut off the holder. I conceived the following arrangement (see Sketch No. 3). We first ascertained if the old unused inlet pipe in holder tank was blocked or had been taken out. When this was found to contain gas, I thought that if a connection was taken from this pipe to the feeding main and a governor fixed and set to open at a predetermined pressure I could devise an automatic lever arrangement to operate the closing and opening of the single inlet and outlet valve. The diagrammatic sketch shows the details.

The *modus operandi* is as follows: When the holder rises to a prescribed height, synchronizing with the closing of the valve, it picks up a suspended balance weight attached to a lever and rod which closes the holder valve.

The governor is set to operate at a differential inlet and outlet pressure of 2-tenths. The holder pressure is 30-tenths, and when the village pressure falls to 28-tenths the governor immediately comes into action. Gas is passed from the holder through the governor to the village, by-passing the holder valve. As gas is being consumed the holder commences to descend, and the balance weight again becomes suspended to the lever which automatically opens the valve and brings the holder into normal action. The village pressure then rises to 30-tenths and the governor closes.

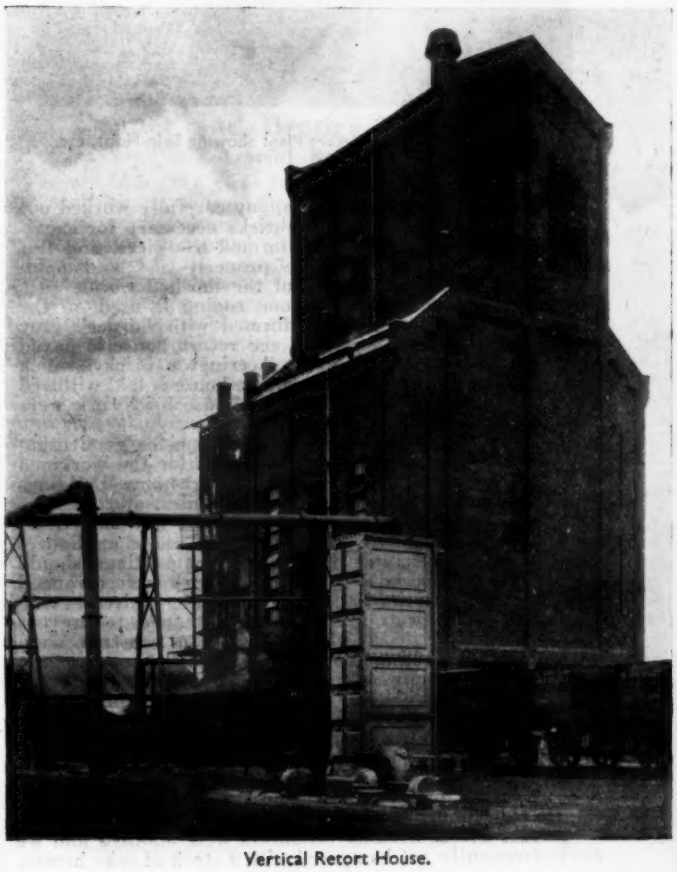
On completion, a pressure recorder was fixed to the main, and the time lag of the opening and closing of the governor, indicated on the chart by a maximum reduction of 2-tenths pressure, was twenty minutes. The apparatus has been in constant use since it was installed with little attention and no trouble.

Retort Installation.

Those of us who have had to deal with the installing of a new carbonizing system and the work involved know exactly what it entails. There is much indecision before a final choice is made of the type of plant to adopt.

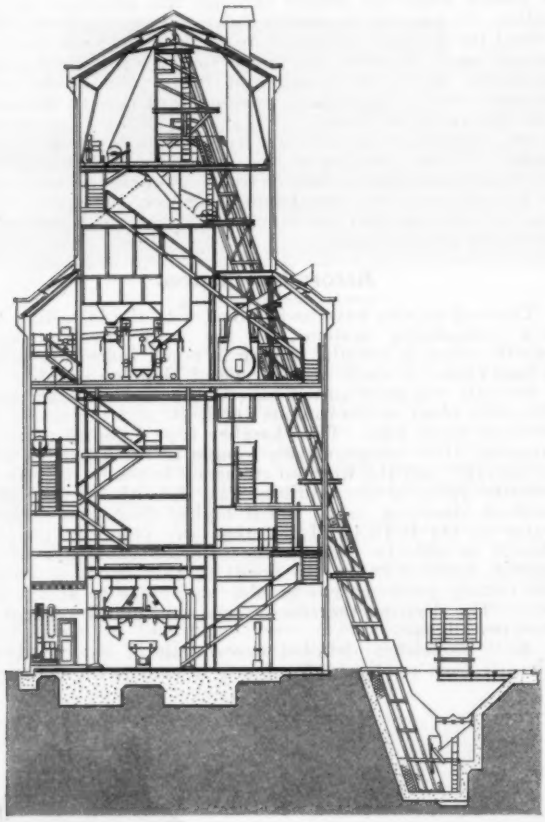
Our site was more suited for either a vertical coke chamber oven plant or continuous verticals, and the choice lay between these two. The chamber type I found quite intriguing; it is comparatively simple in construction, easy to operate, and the thermal efficiency is good. But as the calorific value of the resultant gas, notwithstanding intermittent steaming, is so much higher than our declared value of 410 B.Th.U., I felt that any plant we installed should be able to produce the calorific value gas we required, without having to resort to extraneous apparatus for mixing producer gas or blue water gas to attain that end. The decision therefore was a continuous vertical retort installation.

As a somewhat detailed description of the plant has already been published, I propose to confine my comments



Vertical Retort House.

to features which I felt should be incorporated in our installation. I was desirous of obtaining a more pleasing elevation than many retort houses which I had seen. It must also harmonize with the other buildings erected. Owing to the type of steel-framing necessary for vertical retort structures, the scope for architectural effort is somewhat limited. In the design tall panels were introduced resembling the early English period architecture. The oversail and stepping of brickwork matches our other buildings. A high grade local warm coloured red sand-faced brick was adopted. Cement mortar was used throughout and the brickwork joints were struck and cut.



Sketch No. 4.—Vertical Retort Plant showing Skip-Hoist, etc.

West's Gas Improvement Company carefully worked out the sizes of the various special bricks necessary for encasing the steel stanchions which formed the piers, and this ensured that the brickwork was properly tied, and maintained the correct appearance of the finished work.

A manufactured Portland stone coping is used on the gable ends, and the roofing is formed with Turner's grey asbestos tiles. The flooring of the retort house is paved with red faced hard texture Accrington bricks, which makes a really good job. The engine house is laid with red tiles. Both foundations and retort house brickwork were carried out by a local builder.

Factories of spacious design allow scope for good organization and promote healthy conditions for the workmen employed. This is applicable to retort-house buildings which contain machinery, waste-heat boiler, storage hoppers, &c., and as this plant receives daily and sometimes hourly attention, I was anxious that all these appliances together with flues and dampers of the settings should be comfortably accessible. The platforms were arranged with this object in view, and the intervening staircases connecting the platforms are all gently stepped to prevent that ache in the back which becomes a constant companion after inspecting some vertical installations.

The settings comprise eight Glover-West steaming type retorts of 5 tons capacity per diem, arranged in pairs of four distinct units. The insulation received some thought, and in addition to incorporating "Dome" insulating bricks in the walls of setting, I had the furnace walls also encased. Many years previously I used Molar non-conducting bricks for a similar purpose with beneficial results on the old Holmes-Winstanley vertical plant.

Pressure breeze-burning producers were adopted and we are consequently not hampered with a stock of coke breeze.

The Coal-Raising Plant.

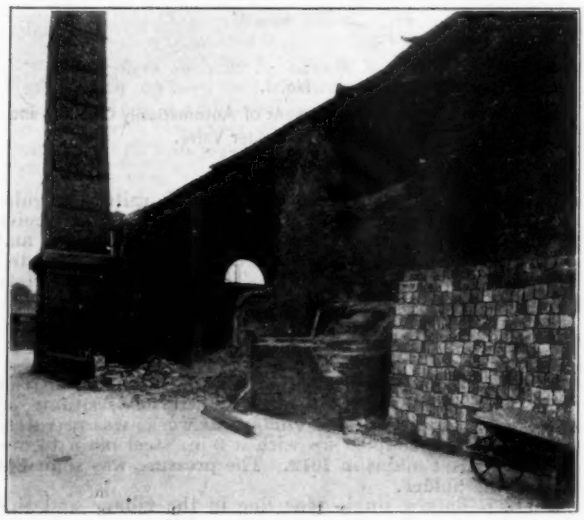
The portion of plant that caused me the most thought before finally arriving at a decision was the coal-raising plant. I have never been entirely satisfied that the bucket conveyor is always the most suitable means of raising coal from pit to bunkers on comparatively small carbonizing installations.

Its adoption is so general that many, I feel sure, must hold a different opinion. However, after fourteen months' use of an automatic skip hoist, my belief has been strengthened. We have no electricity on our works; all machinery is run on steam. The introduction of electric power would have added considerably to our capital costs without corresponding gain in running costs.

In operating skip hoists and lifts, electric power possibly possesses some advantages over steam. The introduction, however, of a patented automatic timing and reversing device for controlling the filling and empyting of the skip has overcome what was previously an acknowledged disadvantage. When this matter was under consideration I had an interview with Mr. Sissons, of Gloucester. His firm had then just tried out their idea on a small plant, and I decided to include its adoption in my specification.

Our skip hoist raises coal from the pit, situated under the railway lines, in one ton lots, and tips it in the overhead bunkers. The hoist is set to handle 25 tons per hour—which it does comfortably. A number of our railway coal trucks have been converted for bottom emptying, enabling quick release of wagons with minimum labour. Illustration No. 4 shows outline of the arrangement. We have previously had experience of the Sisson steam engine and we standardized on that make of engine.

Shortly after testing the plant we found that if the skip hoist were left running after the coal pit was empty there was a tendency for the skip to over-run at the discharge point. After consultation with West's, they fixed up a lever arrangement connected to the steam supply which immediately shuts off the steam when the skip passes a



Old Horizontal Settings being Demolished.

Old Horizontal Retort House now in course of Reconstruction.

predetermined point. This makes the plant foolproof. In the event of repairs to skip hoisting plant, arrangements are made for steam hoist to handle all coal for bunkers and coke required for filling the retorts.

An "Arca" automatic controller is fitted on the foul main for controlling the gas pressure on the retorts. In connection with the water storage feed tanks for controller and waste-heat boiler, we have fitted in addition to indicators an electric alarm bell arrangement set to ring when the water tank levels become low. The plant is fitted with a water meter for registering consumption to waste-heat boiler and a steam meter to register the steam used in retorts. Thermometers are also provided on steam supply, heat exchanger for boiler feed water and exit flue gases.

It is impossible in this Paper to mention all the details of the various installations undertaken, but I will endeavour to give any information required in the discussion.

The cost of the complete carbonizing installation was £15,200. A loan was taken up for £10,000 and the balance was provided out of revenue. All the various plants have been in operation for rather more than a year and without exception the working has been smooth and efficient.

The Old Horizontal House.

It has been decided to reconstruct the old retort house and convert it into stores, workshops, garages, and stove-cleaning shops. Owing to the bad condition of the side wall, this has had to be entirely removed. The roof was pinned up and steel girder framing erected. Panel brickwork is being proceeded with. The complete scheme will provide ample accommodation for dealing with the district staff requirements, which will all be concentrated under one roof.

The two photographs show the old retort house wall in course of demolition and after some of the new brickwork had been built. The work is being undertaken somewhat leisurely by our own staff.

Discussion.

Mr. H. BANKS (Northampton) drew attention to Mr. Shewring's statement that the holders were boosted up by means of a fan about a mile from the gas-works, and that when the holder was full the valve closed. He enquired what was the maximum pressure on the main with the fan running and the valve closed.

Mr. SHEWRING replied that they governed the outlet of the fan to a maximum of 6 in. according to requirements, while the gasholder was weighted to give 3 in. pressure.

Mr. A. ROBERTS (Hereford) said that Mr. Shewring had mentioned purification *in situ*. Could he tell them the oxygen content of the gas and whether he was experiencing any trouble due to corrosion in service pipes?

Mr. SHEWRING replied that the oxygen content was about 0·3; they had not had any trouble from corrosion for many years past, though there had been some trouble previously.

Mr. G. C. PEARSON (Birmingham) asked for an explanation of Mr. Shewring's method of filling the purifier boxes.

Mr. SHEWRING observed that these were built up from the bottom with alternate layers of oxide and 2 in. square wood blocks. The oxide was thus suspended and the pressure was relieved by the woodwork inside.

Mr. T. H. POULSON (Stafford) said that mention had been made of a gas heater in connection with the first section of extensions. Was this for raising the temperature of the gas prior to entering the purifiers? Also, was air admitted separately to each box at will or was it mixed at the entrance to the plant? He asked if Mr. Shewring could give them a description of his method of effluent liquor disposal and if any objection had been raised by the sewage authority as regards the quality of the effluent. He also enquired if he had experienced any trouble in regard to the breakage of the Turner's tiles on the retort house roof. Was much maintenance required in connection with the skip hoist? Very little was necessary with the gravity bucket type.

Mr. SHEWRING stated that they had not arranged separate admittance of air to the purifiers; they mixed it with the gas at the inlet, though, of course, it could be admitted separately. As regards effluent, it happened there was a tip a short distance from the works. This belonged to the Corporation, and he had made arrangements with the canal authority to pump the whole of their effluent into this tip. They had had no trouble with the Turner's tiles; the amount of breakage had been exceptionally small. The skip hoist called for very little attention. Periodically the rope had to be renewed; the present one had run for fifteen months, and it showed very little sign of wear. He had had some experience of rope haulage, and had found it to give very little trouble.

Mr. G. DIXON (Nottingham) remarked, in connection with the syphon pot illustrated, that Mr. Shewring called this an "open" type of syphon; it appeared to be about 30 in. in diameter, and he would like to know the reason for one of this size on the open side. Mr. Dixon said that he had run a pipe from the pump to the syphon, having a vertical pipe 3 in. in diameter with the outlet half way down, and he had never gone to the extent of 30 in. Mr. Shewring spoke of taking water from the canal for the condenser. But was canal water of constant temperature? Mr. Dixon's experience was that the temperature of the water varied from 68° F. in winter to 90° F. in summer, while, furthermore, the quality was not such that he would like to pass to a boiler feed tank without some treatment. In regard to the district holder, when the booster was running and they had filled the holder, the valve closed but the booster was still running. What pressure could the mains be boosted up to without causing dangerous conditions? He noticed that Mr. Shewring decided to install an automatic skip hoist for elevating the coal to the retort house bunkers. He was in agreement with this policy to some extent, because skip hoists appeared favourable as regards first cost and maintenance in comparison with the gravity bucket type; but they had certain disadvantages, chief of which was that in taking coal up in bulk it was impossible to spread it evenly in the bunkers. It was dumped in large units all in one section. It might mix itself to some extent perhaps. If coke was being handled in the same skips the same applied, which would mean a much larger screening plant than would be necessary with gravity bucket elevators. In his own case, when he was handling 3 or 4 cwt. at a time he had to enlarge the area of his screens by something like three times because he was dumping large volumes of coke at the head of the screens.

Mr. SHEWRING, replying in regard to the hoist, observed that the coal went into a single bunker, and chutes spread it sufficiently to the retorts. They had no coke screening plant at Stratford-on-Avon—in fact, they had very little coke. The same hoist could be used for both coal and coke; but actually they did not do so. The coke was handled at night, which saved it having to be brought outside. As regards the canal water, it did have disadvantages in summer for use in the condenser. When the water temperature was higher the condenser efficiency was lower; but there happened to be less gas going through in the summer, and they had not found any great disadvantage in this respect. They had not found the water detrimental except during very dry periods, when there had been some trouble due to scale. The fan was governed to give a maximum pressure of 6 in., though they could put it up another inch if necessary. The size of the syphon could be just what one liked. The advantage of the double size lay in the fact that it did not require attention during the night. They had a syphon delivering condensate at a higher level than the tar mains, which was due to the pressure of the gas at the outlet of the exhauster compressing the liquor and drawing it away.

Mr. R. G. MARSH (Birmingham) observed that he was still not quite clear about the fan. Was the main between the fan and the holder also used to supply consumers *en route*? If so, presumably those consumers had variations in pressure between 3 and 6 in. When the holder was full, what happened to the fan? Did it continue to run or was it controlled automatically?

Mr. SHEWRING said that governors were fitted in most instances to keep the pressure constant. The fan was set at the peak load of their large consumer, who was taking a million cu.ft. per quarter. They ran the fan at breakfast time and lunch time, and shut it off during the night. That was sufficient to keep the holder full and supply the district adequately. The fan was not automatic.

The PRESIDENT, in bringing the discussion to a close, proposed a hearty vote of thanks to Mr. Shrewing for his Paper, which he felt had brought out some very valuable points that would be of benefit to all their members.

The vote of thanks was unanimously accorded, and Mr. SHEWRING briefly acknowledged it.

Copper and Bronze Welding*

A Useful Booklet

The use of copper pipes for hot and cold water services and sanitary intallation has made rapid progress in the last few years. This development can be attributed largely to the increasing use of the welded joint, which not only permits the use of a lighter gauge pipe with a corresponding reduction in the cost of the installation, but has many other advantages as a means of jointing copper. A further development of this process is the introduction of the copper weldable fitting, which for many purposes is preferable to the ordinary bronze welded joint.

There is no doubt that the use of welded light-gauge copper installations will be more generally adopted once authoritative information is available on the technique of the process, for the benefit of plumbers, heating and sanitary engineers, and architects. "Copper and Bronze Welding" has been produced to fulfil this need, and every aspect of the subject has been dealt with in a detailed and workmanlike manner which will appeal to the practical man. The Author, Mr. W. L. Kilburn, M.I.W.E., R.P., is an acknowledged authority on the welding of copper both for piping installations and roof work, and is also a practical plumber. Mr. Kilburn has devoted his time exclusively for many years to the development of this process, and has given valuable advice on the welding of some of the biggest copper installations which have yet been installed in this country. The importance of providing the architect with reliable information on copper pipe welding has not been overlooked, and a series of information sheets on this subject has been recently published in the *Architects' Journal*. Reprints of these sheets can be obtained free of charge on application to the British Oxygen Company, Ltd.

* London: The British Oxygen Co., Ltd., Thames House, Millbank S.W.1. Price, 5s. net; pp. 156.

Southern Association of Gas Engineers and Managers

The Annual General Meeting of the Southern Association of Gas Engineers and Managers was held at the May Fair Hotel, London, on Friday, Nov. 27—the PRESIDENT (Mr. R. J. H. Clark, of Plymouth) in the Chair.

In opening the proceedings the PRESIDENT thanked the members for the excellent attendance at the meeting. He felt sure that the representative gathering that afternoon, together with the interesting Paper they were to hear, would ensure the success of the closing meeting of the year. He referred with pleasure to the presence of Mr. John Terrace, Mr. G. S. Eunson (President of the Midland Association of Gas Engineers and Managers), and Mr. H. C. Smith (Senior Vice-President of The Institution of Gas Engineers).

The minutes of the previous meeting, as published in the "GAS JOURNAL," were taken as read and were duly confirmed.

New Officers and Committee.

The PRESIDENT said that it was now his privilege to propose that Mr. S. E. Whitehead, of Southampton, be elected President of the Association for the ensuing year. As they would remember, said Mr. Clark, he had the pleasure of proposing last year the election of Mr. Whitehead as Vice-President, and there was little he need add to what he had then said concerning his many and varied qualifications, which were so well-known to them. His own close association with Mr. Whitehead during the past twelve months had more than confirmed his belief that their new President would prove worthy of the office, and he was sure the members would approve the unanimous wish of the Committee in putting Mr. Whitehead's name forward for the Presidency.

Mr. J. TERRACE, in seconding the proposition, said that he could not fail to notice the wonderful succession of eminent men in the Gas Industry the Association had had as their Presidents. Under Mr. Whitehead they would be equally successful in the work they were doing, and the Southern Association would maintain the high position they held among the District Associations. He had known Mr. Whitehead personally for many years; apart from that they had witnessed the record of his work and the progress he had made in the Industry. They could not want a more suitable man for their President during the coming year.

The proposition was carried unanimously, and in acknowledging his election Mr. WHITEHEAD observed that he was extremely grateful for the honour they had thus done him. It was the greatest compliment they could pay, and he appreciated it very highly. He thanked Mr. Clark and Mr. Terrace—both of whom he had known a long time—for their kind remarks and the members for their acceptance of the resolution. He had been a member of the Association for seventeen or eighteen years and he did not mind admitting that he had always thought he would like to become President; but he did not expect the honour to come so soon. Once again he thanked them for the honour they had done him and his Company, and said he would do his best to uphold the dignity of the office and the interests of the Association as a whole. In conclusion, Mr. Whitehead stated that it was hoped that in due course an invitation would be extended to the Association to visit Southampton.

Mr. WHITEHEAD went on to propose the election of Mr. D. C. Cross, of Lea Bridge, as Vice-President for the coming year. There was little need, he said, to say anything in support of this resolution because they all knew Mr. Cross so well. He had been a member of the Association since 1910 and had worked very hard in their interests. He had been President of the London and Southern District Junior Gas Association, while they all knew of his record at Lea Bridge. He would make an excellent Vice-President.

Mr. G. R. BULLWINKLE (South Metropolitan Gas Company), in seconding, observed that the wide experience of Mr. Cross would be of great value to the Association.

The resolution was carried unanimously, and Mr. CROSS briefly expressed his appreciation of the honour they had done him in electing him Vice-President of one of the livest Associations in the Kingdom.

The HON. SECRETARY then announced the names of the members serving upon the Committees of the Eastern and Western Districts for the year 1937, as follows:

Eastern District Committee, 1937.

Chairman.—Mr. G. R. Bullwinkle.

Vice-Chairman.—Mr. F. J. Robinson.

Committee.

W. H. Bennett	J. F. Haseldine	F. J. Robinson
C. F. Botley	L. G. Humphrys	R. H. Ruthven
G. R. Bullwinkle	J. H. Hornby	E. F. Smallbone
T. Carmichael	*W. A. Howie	H. C. Smith
*D. C. Cross	D. F. Irving	A. W. Sumner
G. Le B. Diamond	S. Lacey	L. Trewby
J. H. Donaldson	L. J. Langford	W. H. Warren
H. Gage	E. L. Nicholas	*S. E. Whitehead
W. Grogono		

* Members *ex officio* (Rule 9).

Hon. Secretary.—Mr. W. A. Howie.

Representatives to the Main Association (retire 1939).—Mr. H. Gage, Mr. J. H. Hornby, Mr. L. J. Langford, Mr. L. Trewby.

Representatives on the District Education Committee of The Institution of Gas Engineers.—Mr. G. R. Bullwinkle, Mr. H. Gage, Mr. D. C. Cross, Mr. S. E. Whitehead.

Western District Committee, 1937.

Chairman.—Mr. H. Higham.

Vice-Chairman.—Mr. C. Harris.

Committee.

F. Blackburn	S. E. Halliwell	E. Samuel
J. B. Cattle	C. Harris	C. Stapleton
R. J. H. Clark	H. Higham	J. Taylor
J. Hughes Cornish	*W. A. Howie	R. C. Taylor
*D. C. Cross	P. S. Hoyte	A. Thomas
W. E. Dean	S. J. Ingram	H. W. Versey
F. W. Delafield	J. H. Lowther	W. N. Westlake
R. S. Falkner	J. H. Pye	*S. E. Whitehead

* Members *ex officio* (Rule 9).

Hon. Secretary.—Mr. J. H. Cornish, Junr.

Representative on the General Committee.—Mr. J. H. Lowther.

Representatives on the District Education Committee of The Institution of Gas Engineers.—Mr. C. Harris, Mr. H. Higham, Mr. R. Robertson, Mr. W. N. Westlake.

On the proposition of Mr. T. N. RITSON (Worthing), seconded by Mr. E. L. NICHOLAS (Guildford), the Association's Auditors (Mr. J. Donaldson and Mr. J. Urquhart) were re-appointed, Mr. URQUHART briefly acknowledging this renewal of their confidence in himself and Mr. Donaldson, and referring to the admirable way in which Mr. Howie kept the accounts of the Association, which greatly assisted the work of the Auditors.

Proposing the re-election of the Hon. Secretary and Treasurer (Mr. W. A. Howie, of Gravesend), the PRESIDENT paid tribute to his striking qualities; the best gesture of their confidence in him was to re-elect him for another year. The resolution was seconded by Mr. WHITEHEAD, and unanimously approved, Mr. HOWIE briefly returning thanks for his re-appointment and observing that he would be very pleased indeed to carry on for another year.

The following new members were then elected on the proposition of the PRESIDENT, seconded by Mr. CROSS:

F. M. Birks (Gas Light and Coke)	J. W. Swann (Hitchin)
O. Ashby (Whitstable)	J. H. Rioch (Cambridge)
J. H. Greenacre (Snodland)	F. A. Read (Exeter)

Presentation of Certificates.

The presentation of Certificates to successful candidates in the Higher Grade Examinations of The Institution of Gas Engineers in Gas Engineering and Gas Supply was

then made by the President. The complete list of successful candidates is as follows:

EXTERNAL HIGHER GRADE GAS ENGINEERING.

1st Class	G. E. Banner	Margate
,,	N. T. Brake	Bexhill-on-Sea
,,	T. H. Canning	Thorpe Bay, Essex
,,	E. P. T. Chambers	East Sheen, S.W. 14
,,	T. W. Clapham	Bristol
,,	G. Fitton	Dewsbury, Yorks
,,	N. Laird	Wandsworth, S.W. 18
,,	J. R. Martindale	Bishopston, Bristol
,,	A. C. Shilson	Weston-super-Mare
,,	S. E. Balsom	Lowestoft
2nd Class	C. R. Blogg	Croydon
,,	R. P. Donnelly	Richmond
,,	J. A. Dukes	Whitefield, nr. Manchester
,,	R. H. Foston	Torquay
,,	G. H. Petch	Southampton
,,	N. F. Riches	East Grinstead
,,	D. A. Vince	Swindon

INTERNAL HIGHER GRADE GAS ENGINEERING.

1st Class	F. Duckworth	London, N. 17
,,	E. F. Gorman	Sydenham, S.E. 26
,,	R. L. Norton	Mitcham
,,	L. P. Price	Lipson, Plymouth
,,	E. H. Richmond	Catford, S.E. 6
,,	T. S. Ricketts	Hertford
,,	P. S. Weston	Bath
2nd Class	C. P. Cox	West Drayton, Middlesex
,,	C. J. P. Keene	Barnet, Herts
,,	J. D. March	Bathampton, Bath
,,	B. Northen	Longfield, Kent

EXTERNAL HIGHER GRADE GAS SUPPLY.

1st Class	G. Fitton	Dewsbury, Yorks.
,,	G. F. J. Murray*	Pomphlett, nr. Plymouth
2nd Class	C. E. Barralet	Petts Wood, Kent
,,	E. W. Black	Leyton, E. 10
,,	G. H. Crosby	Bishopston, Bristol
,,	C. W. Manning	Bristol, 5
,,	F. W. Nichols	Plymouth
,,	C. H. Pearson	Shirley, Southampton

INTERNAL HIGHER GRADE GAS SUPPLY.

1st Class	G. W. Emrys-Roberts	Kingswood, Surrey
,,	J. A. A. Foot	London, W. 14
,,	H. R. Hedges	Hornsey, N. 8
,,	A. F. Hetherington*	Highgate, N. 6
,,	N. W. Ireland	Cuffley, Herts.
,,	G. E. Kerley	Croydon
,,	J. Malsbury	London, W. 2
,,	J. B. Maylam	Woking
,,	W. M. K. Parnall	Enfield Wash, Middlesex
,,	D. C Rendell	Hinchley Wood, Esher
,,	A. A. St. Leger	Wembley, Middlesex
,,	G. O. Turner	Croydon
,,	R. B. Williams-Thompson*	London, W. 6
2nd Class	N. A. Andrewes	Tottenham, N. 17
,,	J. T. Brookes	Hove, Sussex
,,	D. E. Healy	Kenton, Middlesex
,,	W. J. H. Lynch	Edmonton, N. 9
,,	J. G. Ronca	Rickmansworth, Herts.
,,	J. C. Salmon	Tooting, S.W 17
,,	W. H. Sayer	Sydenham, S E. 26
,,	L. N. J. Taylor	Redhill, Surrey
,,	J. W. Yates	Blackheath, S.E. 3

* With Distinction.

After presenting the Certificates the PRESIDENT observed that he was sure all the members shared his own pleasure at seeing so many names of successful candidates, to whom he offered his hearty congratulations and best wishes for their future welfare.

Contribution to Shewring Fund.

The PRESIDENT, in concluding the formal business of the meeting, announced that the Committee had made a contribution of ten guineas to the "GAS JOURNAL" Shewring Fund.

There followed the presentation of a Paper by Mr. C. A. Deas (Works Engineer at the Hertford Station of the Tottenham and District Gas Company) on "Dilution of Horizontal Coal Gas."

Trade Notes

R. and A. Main, Ltd.: North-Eastern Representation.

Messrs. R. & A. Main, Ltd., Falkirk, ask us to announce that the address of their North Eastern representative, Mr. H. S. Valentine, will be 8, Cromwell Road, Scarborough, as from Dec. 1.

"The Study of Welds and Weld Metal."

Murex Welding Processes, Ltd., Ferry Lane Works, Forest Road, E. 17, have forwarded us a copy of the illustrated booklet, "The Study of Welds and Weld Metal," which contains much interesting data on welding.

"Pyruma" Fire Cement Gun.

We have received from Messrs. J. H. Sankey & Son, Ltd., Canning Town, London, E., a copy of their folder giving particulars of the new "Pyruma" fire cement gun. The "Pyruma" gun, for which many advantages are claimed, is worked by air pressure, and is for washing, coating, or spraying large firebrick linings.

"Poilite" Rigid Rubber Floor Tiles.

We have received from Turners Asbestos Cement Company, Trafford Park, Manchester, 17, a handsome brochure, liberally illustrated, describing "Poilite" Rigid Rubber Floor Tiles, which, it is claimed, are quiet in use, resilient to the tread, easy to clean, untiring, hygienic, waterproof, and durable. The upper surface of the tiles is of rubber; the core is of "Poilite" asbestos-cement, which the makers point out combines all the proved wearing qualities of rubber with rigidity; and the undersurface is also of rubber, being keyed for fixing to a concrete sub-floor.

New Lighting Standards on the Wolverhampton-Birmingham Arterial Road.

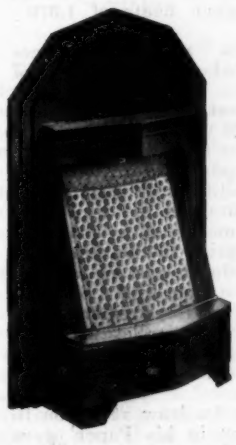
The lighting of the important arterial road from Wolverhampton to Birmingham has been for some time the subject of experiments. Many different types of standard and lantern have been tried in various sections of the road as these run through the areas of various authorities, but no uniformity has as yet been arrived at throughout the whole length of the road.

Considerable interest attaches to the erection at Rowley Regis, of "Adastra" standards, with gas lanterns to replace electrical standards of less height, and these have attracted much favourable notice.

The new lighting employs "Adastra" Standards No. 37, giving an overall length of 29 ft. 8 in., fitted with bracket arms of the "Vesta" type, with overhang of 4 ft. 6 in., and "Venus" type finial. The lantern used is the Parkinson "Maxill." All standards are hot-spelter, galvanized inside and out, and after treatment by a special process are stove-enamelled in alternate colours of cream and light Brunswick green, the bottom section having a coating of "Ruberoid." The stove-enamelled finish, of course, entirely eliminates the cost of further painting, and may be expected to reduce maintenance expense to negligible proportions.

The Cannon "Verbena" V-Inclined Fire.

The Cannon V-Inclined fire is a logical development of the Cannon Inclined fire, which the makers, Cannon Iron Foundries, Ltd., Deepfields, near Bilston, Staffs., claim has attained great popularity during recent years. Our photograph shows one of the new V-Inclined models. This is the "Verbena," the other models available are the "Veronica," and the "Viola." The makers state that measurements with thermopiles and radiometers prove conclusively that the old-fashioned gas fire, in which the radiants were vertical, wasted some of its heat on the hearth. This wasted heat only served to produce currents of hot air which were immediately drawn into the chimney. By inclining the radiants backwards this heat could be more usefully employed in warming the room. It was necessary to find the best angle of inclination, for obviously if one inclined the fire too much, the hearth would not be warm enough, and too much heat would be radiated towards the ceiling. The best angle was found to be at 20° to the vertical. At this inclination the vertical distribution is improved to such an extent that the useful heat radiated from the fire is increased by 20%.



The Dilution of Horizontal Coal Gas

by
C. A. DEAS
(Engineer at the Hertford Works of the Tottenham & District Gas Company)

A Paper read before the Southern Association of Gas Engineers and Managers at their General Meeting held at the May Fair Hotel, London, on Friday, Nov. 27, under the Presidency of Mr. R. J. H. CLARK, of Plymouth.

Some five years ago, as Assistant Engineer to the then Hertford and District Gas Company, I had the privilege of reading to the London and Southern District Junior Gas Association a short Paper on the subject of the dilution of straight coal gas with producer gas. Since that time the Hertford Gas Company has been amalgamated to the Tottenham and District Gas Comauny, and with the latter's greater resources it has been possible to investigate more deeply this method of diluting coal gas. It is proposed in this Paper to give in more detail the results of these findings.

As the standard of the delivered gas is 500 B.Th.U. per cu.ft. and benzole extraction is practised to a high extent, it is possible that some members may wonder why further dilution is necessary or even possible. Further dilution is, however, necessary, as is shown by the following general outline of the operation of the carbonizing plant at Hertford, to give the best C.V. gas, resulting in high efficiency both technically and economically.

The horizontal retort bench at Hertford, at the time of the Author's previous Paper, consisted of six settings of seven stop-ended retorts; these have now been converted to "throughs," though the retort bench appurtenances, incorporating anti-dips, remain as before. The retorts are charged with a De Brouwer type machine which has been slightly modified and is capable of filling the retorts, this being the usual practice.

Within the limits of working of the retort house governor, level gauge conditions are maintained in the retorts *at all times;* this entails the working of a slight pressure in the hydraulic mains to counteract the stack effect of the ascension pipes.

During the winter months 10-hr. charging periods are worked and a yield of the order of 72 therms of 645 B.Th.U. gas is obtained per ton of coal at the retort house. In the summer months 12-hr. charging periods are worked, giving a yield of the order of 74 therms of 623 B.Th.U. gas per ton of coal.

There are two reasons for working 10-hr. charging periods in the winter:

(*a*) To obtain maximum throughput.

(*b*) It is found that a very much better domestic coke, which incidentally compares very favourably with continuous vertical coke, is obtained by working shorter carbonizing periods, though the thermal yield per ton of coal suffers.

Combustion chamber temperatures in the case of 10-hr. charging periods are of the order of 1,450°-1,470° C., though the retorts, due to the high throughput, are, if anything, cooler than with 12-hr. charging when heats of 1,370°-1,400° C. are usual.

Before the conversion to "throughs" 8-hr. charges were usual, with, of course, partially filled retorts to allow of the charges being raked out.

The coals carbonized are from South Yorkshire mines, and the greater proportion, often 100%, is washed slacks, which incidentally is some 8% cheaper than washed nuts.

The first table gives average analyses, &c., of gases obtained under these carbonizing conditions.

The coal gas calorific value is obtained by drawing a continuous sample of the gas, by means of a small exhauster, direct from the foul main prior to the admission of the diluting gases—*i.e.*, air, producer gas, or C.W.G. This gas is passed on via a purifier to a recording "Sigma" calorimeter, checked daily against a Boys calorimeter, occasionally the "Sigma" is run in parallel with the "Fairweather," both on coal gas, as a check on the accuracy of the former. We usually get agreement within + or − 1 B.Th.U.

The writer would like, in passing, to draw attention to the good H.E.V. figure (Dr. Pexton in his Paper[1] gave 35-37·5 for horizontals) and to the low water content of the tar produced. The figure given is the average figure consistently obtained throughout the year and compares very favourably with that which would most probably be obtained if steaming was practised.

	Stop End Retorts, 22 In. by 16 In. by 9 Ft. 6 In.	Through Retorts, 22 In. by 16 In. by 12 Ft.	
		10-Hour Charge.	12-Hour Charge.
Coal throughput, tons per retort per diem	0·7	0·9	0·74
Cu.ft. per ton	11,180	11,150	11,960
Therms per ton	72·1	72·0	74·6
Calorific value, B.Th.U. per cu.ft. (before oxide purification)	645	645	623
H.E.V.	38·2	38·0	38·8
Tar, galls. per ton	10·75	11·0	11·0
Tar, H_2O content	5%	2·2%	2·6%
Tar, specific gravity	Not recorded	1·143	1·152
Gas analysis—			
CO_2	1·5	1·5	1·9
O_2	0·4	0·5	0·4
CO	6·5	6·3	6·3
C_nH_m	3·9	4·0	3·5
CH_4	33·8	34·5	33·6
H_2	51·1	51·1	51·2
N_2	2·8	2·1	3·1

The figures given in the table above (except those referring to 12-hr. carbonizing conditions which represent some three months' working only) are typical everyday results obtained over a number of years working with good, bad, and indifferent retorts.

I feel sure that those present will agree that from these no loss in efficiency is indicated by producing a high quality gas. Certainly working conditions are very satisfactory; stopped pipes are few and readily cleared, and pitched up hydraulics, blocked run-offs, and similar troubles are unknown.

At this point the Author would suggest that the most economical method of working, particularly horizontal retorts, is to aim at obtaining the maximum yield of coal gas therms per foot of retort—not necessarily per ton of coal—and carry out dilution afterwards under complete control and not as appears to be done in many works, particularly small ones, by working the exhauster to maintain the desired quality, this control, of necessity, often being in the hands of the stokers.

Incidentally, by this method one can obtain the best quality residuals—*i.e.*, a good free-burning coke, a tar with low water content, and the minimum of liquor.

Methods of Dilution.

Having obtained our high C.V. gas, the problem was how to reduce it most economically to the standard required for distribution, always bearing in mind the suitability of the diluted mixture to give satisfactory service in consumers' appliances—*i.e.*, the method of dilution must result within narrow limits, in a mixed gas of constant calorific value, specific gravity, and particularly composition.

Taking them in order we have:

(*a*) Steaming of the charge *in situ.*

(*b*) The addition of blue or semi-carburetted gas.

(*c*) The addition of waste gas.

(*d*) The addition of air.

(*e*) The addition of producer gas.

(*f*) Benzole extraction.

(*a*) was most admirably dealt with by Mr. Braidwood[2] at last year's meeting. He showed fairly conclusively that steaming in horizontal retorts is not an economical method of dilution. It has, however, been shown by others that much must undoubtedly depend on local conditions.

(*d*) The addition of a certain amount of air for purifica-

[1] See "GAS JOURNAL," Feb. 13, 1935.

tion purposes is essential, but for obvious reasons it should be kept to a minimum.

(*f*) This is obviously a very desirable method, and should, of course, be practised to its fullest extent, though even so it will normally not reduce the C.V. of the original coal gas to the desired standard.

This leaves items (*b*), (*c*), and (*e*), all of which methods of dilution have been tried out from time to time at the Hertford Works over a number of years, and the Author therefore proposes to deal with them in turn.

Dilution with Blue Water Gas.

This, of course, is quite a straightforward and well tried method of dilution, but has the disadvantages of:

(*a*) Special and somewhat expensive plant is required for manufacturing the gas.

(*b*) It reduces the amount of coke available for sale, perhaps very desirable in some cases, but the writer would suggest that in most cases this coke is of more value when sold as coke.

(*c*) As will be shown later, not always the most economical method of dilution, depending very much, of course, on local conditions.

(*d*) The final mixture of coal/blue water gas can at times be somewhat troublesome on the district.

Dilution with Waste Gas.

This has been tried out at Hertford, but was abandoned owing principally to the fact that it was uneconomical and also raised the total inerts contents of the mixed gas to what was considered to be an undesirable figure.

Dilution with Producer Gas.

This leaves us with method (*e*), which I hope to be able to show as being a very simple, economical, and desirable method of dilution, particularly for straight horizontal *coal* gas, but has, I would suggest, possibilities for diluting intermittent vertical gas in lieu of steaming.

You will notice that the word "coal" is emphasized, since so many so-called horizontal retort coal gases are a mixture of that gas *plus* waste gas and air, fruits of overpulling and/or leaky retorts.

Now there are several obvious methods of obtaining the producer gas required for dilution, among which may be mentioned in particular:

(*a*) Drawing the required quantity of gas from one or more of the retort bench producers.

In the case of internal producers, which are common with horizontal retorts, this suffers from the defect that any fluctuation in the fire level, or other disturbance, due to clinkering or even pricking up, has a temporary adverse effect on the quality of the gas; moreover, it is often the case that the producer is already working to capacity in carrying out its normal function of supplying the heat needs of the setting.

Another disadvantage is, of course, that one has to manufacture one's producer gas from whatever fuel is being used in the producer—usually coke. Other low-grade fuels are available, and can be used for this purpose with obvious advantage.

(*b*) The simple conversion of a C.W.G. set to make producer gas; this is only practicable when a set is available.

(*c*) The building of a special plant to make the producer gas required for dilution purposes only, giving complete control over the quality and quantity of the gas made and *also* the fuel used.

At Hertford first attempts at producer gas dilution were made some eight years ago; a connection was made to one of the retort bench producers and the required amount of producer gas drawn into the coal gas stream at the exhauster inlet. The producers at Hertford were at that time somewhat on the small side; consequently, for this reason and the difficulty of maintaining satisfactory control, this method was soon abandoned and another source of production sought.

Use of C.W.G. Plant for Producer Gas Manufacture.[3]

Two water gas sets were available, and nothing seemed simpler than to make use of one of the plants, using the relief holder in the same way as it was used when making C.W.G.—*i.e.*, as a balancer between the rate of production and the rate of use of the gas, the connections to and from the holder were, of course, in being, as also was a Kent shunt type meter for measuring the crude gas. The gas, either C.W.G. or producer, could thus be "made" into the relief holder, from which it was drawn at the required rate via the Kent meter into the inlet of the exhauster, where it mixed with the coal gas.

One of the C.W.G. sets was accordingly fitted up with a Meldrum steam blower so arranged as to deliver its rated quantity of air direct into the base of the generator.

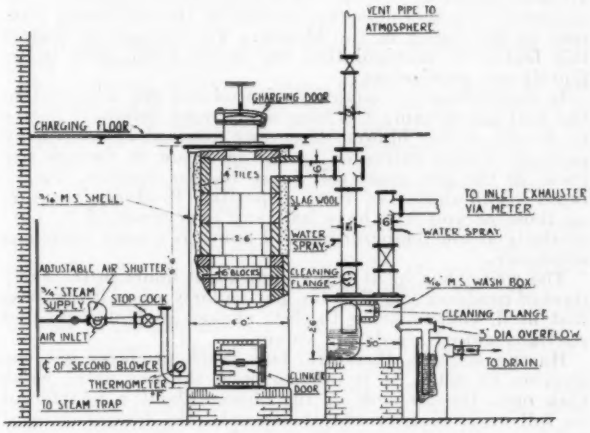
To start the plant gas-making, assuming the generator being full of hot coke, it was merely necessary to turn the steam on to the blower and shut the stack valve, the resulting producer gas passing forward into the relief holder. All other valves on the plant, except gas outlet, valve from washer, overflow from washer, &c., were in the closed position.

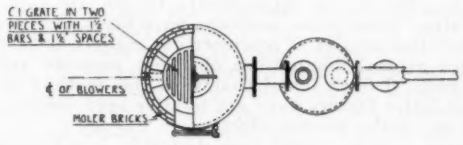
As when making water gas the fuel used was large coke, which was fed into the generator in buggy loads at intervals of about 4-5 hr., clinkering was carried out every other day; the total attention required amounted to about 20 min. per 24 hr.

This method of producer gas manufacture was carried on for about three years without any trouble whatever, and as it was not desired to make C.W.G. and producer gas at the same times, the plant, together with the relief holder, &c., was always available for C.W.G. or producer gas, whichever diluent was required.

Special Producer Gas Plant.

In 1932 the Hertford Company was amalgamated with the Tottenham Company, and the output of the Hertford Works was increased by the amount of the output of the Ware Works, which was shut down and supplied from Hertford.





The extra load made it desirable to manufacture producer gas in a plant entirely independent of the C.W.G. plant, so that, if necessary, both gases—*i.e.*, producer gas and C.W.G.—could be admitted to the coal gas stream together. The desirability of this was further emphasized by difficulties experienced on the district with lighting back of, in particular, burners of cluster lamps, producer gas, as will be shown later, having a beneficial effect in mitigating this difficulty.

At the Ware Works there were two C.W.G. plants, one in practically new condition, the other in poor condition except for the generator. The latter was accordingly dismantled and brought over to Hertford, where it was re-erected in an odd corner of the C.W.G. house as being a convenient site. It was relined, provided with a new set of firebars, the old air blast inlet was banked off, and a connection taken from what was originally the outlet to the carburettor down to a wash box provided with a dip pipe to give about 2 in. seal. This connection is also provided with a vent pipe for use when clinkering or if the plant requires to stand under slow fire. From the wash box a connection was taken via a small cylindrical station meter, also salvaged from the Ware Works, direct to the

[2] "Steaming in Horizontal Retorts." See "GAS JOURNAL," Dec. 4, 1935.

[3] See Paper read to L. & S.D.J.G.A., December, 1931.

inlet of the exhauster. To the base of the generator were affixed two Meldrum blowers, one with a capacity up to 4,000 cu.ft. of air per hr., the other with a capacity of 6,000 cu.ft. per hr.

Complete, the plant is as shown in sketch and has a capacity from a minimum of 2,500 cu.ft. per hr. (below this rate of make the C.V. of the gas rapidly falls off, since the rate of gasification is not high enough to maintain the temperature of the fuel bed) up to 10,000 cu.ft. per hr. This is not necessarily its maximum capacity, but the highest rate at which it has been desired to make gas. Normal maximum hourly requirement is of the order of 6,000 cu.ft.

The plant cost £80 when fitted up completely ready for gas-making, this figure including the cost of certain new parts that were required—*i.e.*, blower, lining bricks, and sundry other items. It has been estimated that an entirely new plant of similar capacity would cost some £150 exclusive of foundations, gas and water connections, and fuel hoist. This last item is not essential, since the fuel can readily be carried up in sacks and is the usual procedure at Hertford. A figure of £200 would probably cover the whole job, but would not allow for a meter, which, though desirable, is not essential.

Those present will agree with me that most works except the very smallest have usually a fitting and maintenance staff who could readily tackle fabrication and erection of such a plant.

The Meldrum blowers are each provided with an air slide so that the amount of gas made is under complete control at this point. The valves in the gas main are normally worked wide open and only closed during clinkering or when it is required to shut the plant down.

This matter of the provision of an air slide is very important, since to obtain the best quality of producer gas it is essential to maintain the temperature of the steam/air mixture at 59° C. or within close limits either side as recorded by a thermometer inserted in the air/steam mixture at the outlet of the blower. To attempt to control this factor by manipulating the steam valve only is definitely not satisfactory.

In controlling the quantity of producer gas admitted to the coal gas stream, it is here again most definitely better to do this at the blower, since any attempt at control by partially closed valves or by the insertion of various size cocks in the gas main will cause endless trouble, due to rapid accumulation of tarry deposits. Producer gas tar, as those of you who have had any experience of it, particularly at low temperature, will know, is a most tenacious substance.

The writer has spent many unpleasant hours in the early days of producer gas dilution, particularly when breeze was first used, endeavouring to clear choked control cocks and partially closed regulating valves.

Having decided, therefore, how much producer gas one requires to make, it is best to open the gas valve wide; then open the air slide of the blower about a quarter of its full area, turn on the steam until the temperature of 59° C. or thereabouts is reached. It is a few minutes' job only to check up from the meter the amount of gas being made, and any reduction or increase of the make can readily be effected by adjustments to the air slide and steam valve. Once these positions have been set it will be found that the amount of producer gas made will vary but little with normal fluctuations of steam pressure and exhauster pull. I have found that with this method of control these latter factors have got to alter very considerably to have any really serious effect.

Of course, a meter, while very desirable, is not essential, and in its absence one would have to set the quantity of gas being made by trial and effect. Having obtained the correct settings of the air slide and steam valve for any particular condition, it is only necessary, knowing the air slide setting, to open the steam valve until the correct air/steam mixture temperature is obtained. One can thus be sure of repeating the previous condition as to quantity of gas being made within close limits. I have actually worked without a meter, adopting the method outlined, and it is surprisingly simple and effective.

Charging fuel to the plant is quite straightforward; at Hertford use is made of the C.W.G. plant charging buggy; the fuel can, of course, be shovelled straight into the producer in pre-determined quantities.

At low makes it is not usual to shut the plant down to re-fuel, the charging door is simply opened, the fuel shot in, and the door closed again, about two minutes' operation in all, except that when gasifying small fuel it is sometimes necessary to put a long bar down into the fire to make certain it is not "hanging up." At high makes it is usually necessary to turn off the steam to the blower; otherwise there is a tendency to get a somewhat large volume of gas burning at the charging door when opened. This naturally makes it difficult to get the fuel in, and is, of course, particularly undesirable if it is necessary to rod the fire at all.

When the fuel is in and the door closed again, it is only necessary for the operator, a retort house stoker, to turn the steam on again until he reaches his 59° C., which is marked, and the plant continues to make gas at the rate at which it was originally set.

Charging is carried out at intervals of from 4-8 hr., usually in quantities of from 2-3 cwt., depending on the rate of make; 8 hr. is a desirable maximum interval, as it ensures the plant is looked at once each shift at least.

Clinkering is carried out usually every other day; on low makes—*e.g.*, during the summer months—once every three days suffices. The method of clinkering is first to shut down the plant and open the vent to atmosphere. Insert a rectangular M.S. plate into the fire through the clinker door, which is provided with lugs running the full depth of the door frame; this plate is sufficiently long to go right across the producer and holds the fire up while the clinker and ashes on the fire bars are removed. When using coke as fuel, this usually suffices to clear the whole fire and takes about 10-15 min. With low-grade fuels, such as breeze, it is often necessary to bar down clinker from the top of the fire, in which case 30-40 min. may be taken over clinkering.

Some of you may be wondering what happens if the exhauster pull is greater than the wash box seal of 1½ in., which it probably would be. At Hertford the exhauster pull has been worked at from 2-6 in. w.g. with the object of finding out what does happen.

At the lower figure the meter practically stops, indicating that very little is being drawn forward. At the higher figure there is certainly a tendency for the meter to speed up. The control of volume is effected at the inlet to the producer, and as soon as the charging door is opened this goes out of action. What is practically all waste gas goes forward; as the charging door is normally only open for a very few minutes, the extra volume of gas drawn forward during the interval is not of serious consequence. If, of course, the door is likely to be open for any period, then the gas valve should be shut.

Type of Fuel Used.

The fuel used when the manufacture of producer gas was first commenced was large coke, which provided no operating difficulties and gave a good quality of producer gas.

Having got the plant working satisfactorily from a technical point of view, attention was then turned to the possibility of making use of a cheaper fuel—in particular coke breeze. This was accordingly charged into the producer instead of coke, and except for a tendency to get a black core in the fire, it gave a gas which compared very favourably with that obtained from coke.

All went well until an attempt was made to clinker the fire. The clinker plate was duly inserted and the clinker withdrawn, but, as soon as any attempt was made to withdraw the plate, the fire commenced to run out of the doorway. By the time the plate was withdrawn, very little fire was left in the producer. To overcome this difficulty it was decided to let the fire get rather low before clinkering, and then fill up with fresh fuel as soon as the clinker had been removed. The fire was allowed to draw up by turning on the blower and discharging the resulting products out through the vent until the gas reached a reasonable quality.

All appeared to be going quite well until the fire was opened up for the next clinker, when the firebars were found to have disappeared as such and appeared as a twisted mass of burnt metal on the floor of the ashpit. The fine breeze had, of course, trickled through the spaces between the firebars and burnt on the floor of the ashpit, with the above result.

Coke was immediately reverted to again as the fuel, since even the low cost of breeze did not justify new firebars at each clinker. It was felt that either the grate would have to be specially designed to handle the small fuel, or else the producer would have to be emptied at each clinkering and started up again on coke, following with breeze. The latter suggestion to overcoming this difficulty gave birth to the present method of using breeze as a fuel without any modification whatever to the grate.

Assuming the producer to be started up from cold, using coke as a fuel, as soon as the plant is working normally breeze is charged in, but the last two charges of fuel before clinkering are large coke. When the clinker door is opened up the bulk of the fuel bed above the clinker is coke, which, of course, does not run out.

The fuel, after clinkering, is again breeze, and by the time this gets down to the bottom of the fire a layer of clinker and ash has formed over the firebars to prevent the breeze running through. This method of gasifying

breeze has been in use for the past three years, with complete success. It means using a small quantity of coke (up to 20% of the total fuel). In the writer's opinion it is, however, far more satisfactory than completely emptying the plant each time.

During the past summer attention was drawn to the possibility of using slurry from the settling tank of the hot coke conveyor as fuel for this plant. Up till then this had to be carted away and dumped as worthless.

The plant was worked in precisely the same manner as when using breeze. Instead of putting in a full charge of breeze when re-fuelling was necessary, half a charge of slurry was put into the fire followed by half a charge of breeze to prevent any tendency the slurry might have to blow over as it became completely dried. The effect on the cost of manufacture will be readily appreciated. Up to 50% of the fuel used on this plant is now slurry, which, when drawn from the collecting pit, contains approximately 30% water. It is spread out on the charging floor for 2-3 days before being fed to the producer, by which time the water content has dropped to something of the order of 20 to 25%.

One of the chief difficulties with the use of both breeze and slurry, particularly with the latter, is the tendency for the fire to burn round the periphery of the producer, thus leaving the centre black where the fuel tends to cake, also the clinker does not travel to the bottom of the fire so readily; it is accordingly necessary to bar the fire down at every firing, about 2-3 minutes' work only.

Another difficulty which has been experienced, again particularly with breeze and slurry, is the formation of a very viscous tar which was continually blocking the overflow from the wash box and drains from the mains—in fact, anywhere where any restriction occurred the trouble was experienced. It has been found with even the high volatile content of the slurry, very little appears as a permanent gas, but comes off as a tarry vapour, which condenses out at the first opportunity.

When the plant was first erected, it was provided with water sprays with the object of reducing the temperature of the gas before it reached the meter. It was thought that by cooling the gas the tar would deposit more readily; it did that all right, but could not then be induced to run out of the mains.

Experiments were then carried out on a sample of the tar to find at what temperature it would remain fluid. 120° F. was eventually found to be the optimum minimum temperature. Accordingly the water to the sprays was reduced so that the gas temperature at the meter outlet is always at least up to this temperature. It appears from experience that so long as the gas does not drop much below this temperature before meeting the coal gas stream, no trouble from choked run-offs, &c., need be feared. It seems that once the two gases meet, the coal gas tarry vapour looks after the producer gas tar. No trouble has ever been experienced after this stage.

The adoption of this method of handling the crude gas gives the minimum of trouble in keeping gas connections and drains clear. We do, however, from time to time have to shut the plant down and remove the accumulations of hard carbon which occur in the connections from the producer to the wash box. Cleaning flanges are provided for this purpose, as shown, also accumulations of fliers have to be removed from the wash box occasionally.

It might be as well to mention that the producer gas meter, an ordinary cylindrical cased wet meter made by the Gas Meter Company, works quite satisfactorily under this high temperature. Gas oil is used as the sealing medium to assist in minimizing any bad effects the crude gas might have on the drum.

The calorific value of the gas is recorded on a " Sigma " B.Th.U. recorder, checked daily by a Boys calorimeter modified to burn producer gas. The stream of producer gas required for these tests is obtained by a small exhauster which draws off a continuous sample from the outlet of the meter and passes it on via a purifier to the calorimeter.

Operating Results.

[Taken from Normal Everyday Working.]

Fuel Used	Large Coke.	Large Coke 22%. Breeze 78%.	Large Coke 14%. Breeze 46%. Slurry 40%.
Lb. of fuel per 1,000 cu.ft. gas	13·3	13·2	14·4
C.V. of gas (observed)	123	132	129
Gas analysis—			
CO_2	6·6	5·6	5·9
O_2	0·0	0·0	0·0
CO	25·0	27·7	26·0
CH_4	0·1	0·4	0·4
H_2	14·2	12·9	13·2
N_2	54·1	53·4	54·5
Temp. of steam/air mixture	59° C.	59° C.	59° C.
Steam per 1,000 cu ft. of gas (calculated)	8·0 (approx.)	8·0 (approx.)	8·0 (approx.)
H_2S content, grains per 100 cu.ft.	70–80	Varies 50–120	Varies 30–120

Analysis of Fuel.	H_2O.	Ash.	V.M.	
Coke	2·2	5·4	3·4	As charged to producer.
Breeze	4·0	7·7	7·7	
Slurry	23·9	9·3	16·5	

Screening Analysis.	Below ¼ In.	¼ In.–½ In.	½ In.–¾ In.	¾ In.–¾ In. Square Mesh.
	%	%	%	%
Slurry	67	33	*Nil*	*Nil*
Breeze	10	16	60	14

Admittance of Producer Gas and Control of Calorific Value of Mixed Gas.

The producer gas is admitted in the desired quantities at the inlet of the exhauster, as already remarked. This, of course, has definite advantages, on small works in particular, inasmuch as no auxiliary plant is required for exhausting, washing, and purifying the producer gas. In the Author's opinion also a much more intimate mixture is obtained by passing the two gases together through the exhauster, washer, purifiers, &c.

This method removes the difficulty, already mentioned, of dealing with producer gas tar, and since the impurities present amount in particular to H_2S only to the maximum extent of some 120 grains per 100 cu.ft., no adverse effect need be feared on the purifiers. Purifying charges at Hertford have over a number of years stood at 0·06d. per therm, wages and materials, which does not suggest much difficulty in this direction.

As indicated earlier in this Paper, the volume of producer gas made can be, and is, most readily controlled by adjustments to the steam valve and air shutter on the blower. In practice it is found possible to make these settings to give the required quantity of producer gas, and then the plant can be left to look after itself, apart, of course, from re-fuelling.

The retort house stokers simply work their retort house governor to maintain level gauge conditions in the retorts and, of course, keep a watch for leaky retorts and mouthpieces. The quality of the resulting mixed gas varies but little, and in actual practice the stokers never see the quality of the gas they are making.

The calorific values of coal gas, producer gas, mixed gas, inlet holder, and C.W.G. (when made) are recorded on " Sigma " B.Th.U. recorders, which are checked daily against a standard Boys non-recording calorimeter; town gas calorific value is recorded on a " Fairweather " recording calorimeter.

It is usual to check up the quantity of producer gas entering the coal gas stream once per day and make any adjustments to suit the quantity of coal gas being made, air required for revivification, &c. Another check is made if necessary last thing at night, after which the maintenance of the correct pressure condition in the retorts is relied upon to keep a constant calorific value of the delivered gas. At times of even output no adjustment of the quantity of producer gas being made is found necessary for several days.

The calorific value of the delivered gas is very steady, and under actual working conditions it is extremely rare for a variation of more than 10 B.Th.U. either side of datum to occur in the town gas. Specific gravity is also continuously recorded, and here again straight line conditions are the rule.

Automatic control of the volume of producer gas admitted has been seriously considered on more than one occasion, but the writer feels that in view of the results obtained by simple hand control this refinement is not justifiable.

As a matter of interest, the official quarterly average of the delivered gas, as obtained by six spot tests per quarter, are given over the past four years.

—	Mar.	June.	Sept.	Dec.	Tests during Year.	
					Max.	Min.
1933	500·9	500·4	501·5	501·9	509·9	493·0
1934	502·8	501·0	501·8	501·1	507 2	494·5
1935	502·1	500·8	502·6	501·4	511·2	490·0
1936	500·6	502·2	501·4	..	508·9	494·4

Those of you who, like the writer, do not have the advantage of a continuously recording official calorimeter,

will no doubt appreciate how difficult it is to keep near the declared standard without the danger of falling below it, especially when working in and out of one holder, which is the usual practice at Hertford.

Use of Coal/Producer Gas Mixture on District.

Below are given typical figures in respect of thermal yield, gas analysis, &c., resulting from the dilution of coal gas with (*a*) blue water gas, (*b*) producer gas, (*c*) waste gas.

—	(*a*)	(*b*)	(*c*)
CO_2	2·1	1·9	3·1
O_2	0·8	0·7	0·8
C_nH_m	2·3	2·4	2·3
CO	15·6	10·1	5·7
H_2	48·9	43·8	42·2
CH_4	23·7	26·4	29·1
N_2	6·6	14·7	16·8
C.V. of mixed gas B.Th.U. per cu.ft. (wet basis)—			
Inlet benzole washer	526	526	526
Outlet " "	496	496	496
C.V. of coal gas B.Th.U. per cu.ft. (wet basis), before purification	650	650	650
C.V. of diluent gas B.Th.U. per cu.ft. (wet basis), before purification	300	130	..
Theoretical vols. of air required for combustion	4·46	4·49	4·59
Calculated C.V. of air/gas mixture at burner head, B.Th.U. per cu.ft.	90·9	90·3	88·6
Specific gravity of mixture	0·492	0·523	0·534
% diluent gas (vol.)	27·0	18·0	14·0
% air added (vol.) for purification	5·0	5·0	5·0
Sulphur compounds, grains per 100 cu ft.	12·1	12·0	12·0
Crude benzole, galls. per ton of coal	3·5	3·5	3·5
Coal gas, therms per ton of coal	72·0	72·0	72·0
Total mixed therms per ton of coal (inlet benzole washer)	84·0	75·0	72·0
Total d/d gas, therms per ton of coal	79·0	70·0	67·0

For the purpose of rendering the above results strictly comparable, the figures for each individual mixture have been based on 10-hr. working.

A study of these figures reveals, among other facts, the low inert content of the coal/blue water gas mixture and the high inert content of, in particular, the coal/waste gas mixture. The air required for combustion and the calorific value at the burner head figures slightly favour the coal/blue water gas mixture, with the coal/producer gas mixture a good second.

Now on these figures, from the district point of view, the coal/blue water gas mixture would appear to be the right one to adopt. It has, however, been found over a number of years by experiments in the laboratory, confirmed by results on the district, that the coal/producer gas mixture is far more satisfactory.

The laboratory tests were carried out on standard lighting burners as normally supplied for use on the district. It was found that varying the proportion of producer gas in the mixture over a wide range definitely does not upset such burners; they are more easily adjusted without the danger of their lighting back or going out with a bang, which results, in the case of lamps, in blown mantles. In the case of the coal/water gas mixture the burners were found to be very sensitive to changes in the percentage of water gas present, and a slight turn of the air shutter will readily cause the burner to "hum" or even light back.

Candle power tests carried out by the Company's Public Lighting Superintendent on a standard lighting burner gave, under identical conditions, results which, if anything, favoured the producer/coal gas.

A 3% drop in the calorific value, which in other words means an increase in the percentage of diluent gas present with coal/producer gas mixture, has been observed to have no serious repercussions on the district. A similar drop with coal/water gas mixture immediately results in particularly finely adjusted burners "humming," and, in bad cases, lighting back has been observed to occur.

A drop of 1% in the calorific value of a coal/water gas mixture has been known to cause trouble in exceptional cases—*e.g.*, when a high percentage of water gas was being sent out.

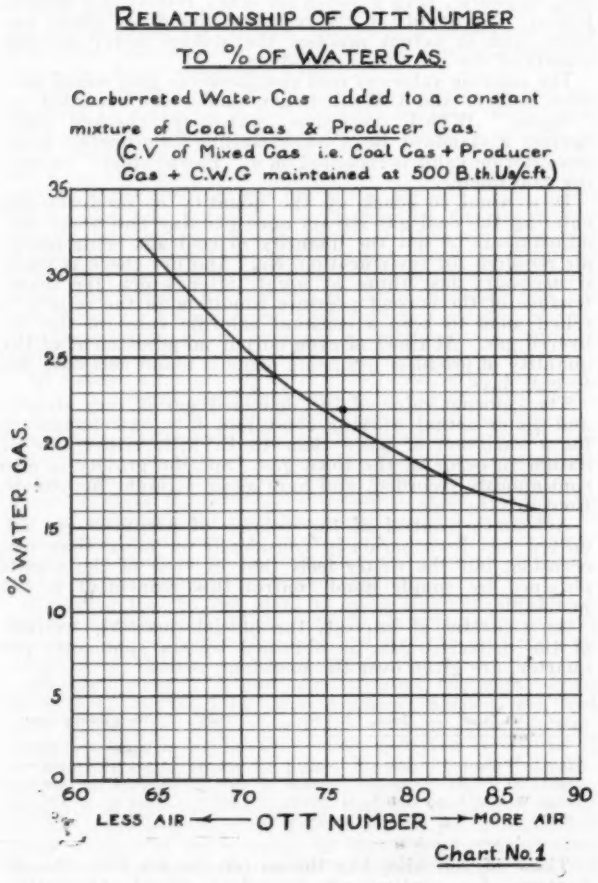
The shortage of carbonizing plant necessitates water gas being sent out during part of the winter months, and a method has been devised to keep control over this lighting back property. This consists in practice of a simple bunsen burner provided with a graduated air-shutter and a water jacket round the mixing tube. Gas is delivered to the burner at constant pressure, and the air shutter is gradually opened until the burner is just on the point of lighting back; this point is noted and termed the Ott number as comparing with the German method of observing the same feature.

With producer/coal gas mixture the setting of this shutter is always high up the scale and varies but little. With the admittance of water gas the reverse occurs, and it is interesting to note how variations in the water gas content do affect the Ott number.

This is well illustrated by the graph which has been prepared from actual observations on gas sent out on to the district during last winter.

During the time that water gas is being sent out this burner is in constant use, and we endeavour to keep our Ott number above a certain low limit, which has been found from trial and effect, by always keeping at least some quantity of producer gas in the mixed gas.

(To be concluded.)



Western Junior Gas Association

Visit to Norton Hill Pit

The unusual nature of this visit attracted on Nov. 21 a large number of members, so that the special arrangements made by Sir Frank Beauchamp, Bart., and his co-Directors of the Somerset Collieries, Ltd., for the visit were well rewarded.

Members descended the pit and proceeded to the workings, 1,500 ft. below the surface, conducted by the Underground Manager and several foreman colliers.

The visitors were subsequently entertained at tea at the Waldegrave Arms, Radstock, where they were welcomed by Mr. Ian F. H. Beauchamp, on behalf of the Directors. A vote of thanks to the Company and their staff for the excellent arrangements and for their hospitality was proposed by the President (Mr. S. B. Jones, of Clevedon) and seconded by Mr. J. E. Akroyd (Swindon G.W.R.).

SYMPOSIUM ON

The Production and Utilization

OF

Domestic Coke

A Joint Meeting of the North-Western Section of the Institute of Fuel and the Manchester District Association of Gas Engineers was held on Nov. 18 at Manchester, when a discussion was opened by Mr. A. Marsh, M.Sc., General Secretary of the National Smoke Abatement Society. Last week we published the contributions of Prof. J. W. Cobb and Mr. H. J. Hodsman and Mr. E. W. L. Nicol. Below we continue with the contributions of Mr. P. J. Askey, Dr. R. A. Mott, and Mr. H. H. Thomas.

Domestic Coke by Alkali Activation

By P. J. ASKEY, Research Department, Winnington

The work done several years ago by M. F. Bligh and H. J. Hodsman at Leeds showed that the addition of sodium carbonate to a high temperature coke increased the rate of combustion in an open grate and enabled a more pleasing and a more flexible fire to be produced. This was only one example of the activating effect of alkalis on fuels which has been so admirably investigated by Prof. Cobb and his collaborators.

Since the publication of this work nearly ten years ago the alkali process for the activation of fuels has received very little attention from the carbonizing industries, in spite of the very great urge that has existed for the production of reactive solid smokeless fuels. The important reasons for this are, firstly, the fear of alkali attack on the refractories of retorts and coke ovens, and, secondly, the cost of the large quantity of sodium carbonate found necessary to give the activating effect. About 5% of sodium carbonate seems to have been the minimum quantity required with normal coal or coke, and this would cost at least 5s. to 7s. per ton of fuel.

We have recently done some work to see if this quantity of sodium carbonate is really necessary for activation, and the first part of this work was published in July, 1935, in *Fuel*. It is only necessary briefly to summarize the results given then and those obtained more recently. It was found that in ordinary coke—containing from 5% to 10% ash—the acidic constituents of the ash combined with the sodium carbonate added. Consequently a considerable portion of the sodium carbonate was put out of action so far as any activating effect was concerned. It was then shown that if a mixture of lime and sodium carbonate was added before carbonization the lime combined preferentially with these acidic constituents, leaving the sodium carbonate free to activate the coke. In this way it was possible to obtain the maximum activity by using lime *plus* 0·5% or 1% sodium carbonate. There are three advantages arising from this:

(1) Less lime than sodium carbonate is required to neutralize the acidic constituents of the ash (owing to the divalency of calcium). Consequently the total addition of lime and sodium carbonate is less than sodium carbonate alone.

(2) Lime is cheaper than sodium carbonate, so that the cost of activation is considerably reduced.

(3) The possibility of alkali attack on the refractories of carbonizing plant is reduced because of the smaller amount of sodium carbonate added.

These considerations should make a great deal of difference both to the economic and practical application of alkali activation, and from this point of view experiments have been made, and are still in progress, on the activation of coke oven and gas-works coke. These experiments will be described in the contributions to this discussion by Dr. Mott and Mr. Thomas.

We have come to the conclusion that it is most advantageous to add the lime and sodium carbonate before carbonizing. The addition of the materials after coking presents difficulties which at the moment seem impossible to overcome. Lime should only be added as a slurry or a solid, and we do not think it would be easy to obtain a uniform and controlled distribution. Sodium carbonate could, of course, be added as a solution, for example, during quenching, but the control of the amount added would be difficult. Addition of lime before carbonizing and sodium carbonate on quenching would mean two operations, which would increase the cost of the process. Apart from the practical difficulties, any advantage due to the increased gas production, shown by Prof. Cobb, would be lost. The addition of alkali before carbonizing seems, therefore, to be the most suitable method of activation.

In considering what alkali activation will do for the production of a satisfactory domestic coke, it is first necessary to see what properties are required in a domestic coke. It is well known that if a special grate, such as the "Metro" or "Eagle"—coupled with gas ignition—be used, ordinary graded gas coke or even oven coke can be burned. Some people would regard this as a satisfactory solution of the smokeless fuel problem, but I would venture to suggest that even when burned under these circumstances ordinary coke does not ignite as readily or burn up as quickly, and is not as flexible as many people would wish. But apart from this, many people have not the means or the inclination to install a special coke-burning grate with gas ignition. What these people require, and I should think they represent a majority of the population, is a solid smokeless fuel which can be ignited with paper and sticks, and which will give a cheerful fire in the relatively inefficient type of open grate generally in use for burning raw coal. The better types of low-temperature coke satisfy such requirements, but the cost of such fuels seems to be too high at present for them to be able to replace raw coal burning among the great mass of the population.

I am aware that a great deal of work has been done on the production of an active high temperature coke which satisfies the requirements I have mentioned, by processes of blending and the carbonization of special coals. The "Dryco" process used by the Liverpool Gas Company has proved successful, but depends on the selection of special coals and modification of carbonizing conditions. What is required is a process with a much wider application, which can be used in vertical or horizontal retorts or in coke ovens, and in which coals of a wide range can be used. It is here, I think, that alkali activation can come to the aid of the processes which are not quite successful and enable them to produce a satisfactory domestic coke.

Perhaps it would be as well to define more closely the qualifications we require of an open-grate coke. I admit that the ultimate court of appeal is whether the householder will buy the coke. But for purposes of comparison we must have a more scientific definition. I shall take the critical air blast test. This test, as you probably know, is designed to measure the reactivity of a coke by finding the minimum air rate which will keep the coke burning when it has been ignited by a standard method. The conditions of the test are fixed, and the reactivity of the coke is expressed as the minimum air rate in cu.ft.-min. The greater the reactivity of the coke the lower is the critical air blast.

We have found, and Dr. Mott and Mr. Thomas will confirm what I say, that the critical air blast value of a coke bears quite a close relationship to the behaviour of the coke in the open grate. A coke with a C.A.B. not greater than 0·038 to 0·040 will burn up quite readily in an ordinary

open grate to give a cheerful fire with flames, lasting well. The fire will leave very little unburned carbonaceous material, and will recover well on refuelling. At the same time such a coke will ignite with 4 to 7 cu.ft. of gas, which is roughly equivalent to ready ignition by the usual household method of paper and sticks.

The cokes normally produced by gas-works, and some oven cokes, have generally C.A.B. values between 0·050 and 0·065, varying, of course, with the coal used and with the conditions of carbonization. They also require 12 to 15 cu.ft. of gas for ignition. It has been found that the effect of alkali activation is to decrease the C.A.B. of a coke by 0·01 to 0·02. The extent of the increase in activity due to alkali varies somewhat with the coal used and with the condition of carbonization. The following generalizations may be made as a result of the experience we have had so far. The more reactive the coal used the greater is the effect of alkali in increasing the activity of the coke made. Under normal carbonizing conditions the effect of alkali activation is more marked in vertical retorts than in horizontal retorts or coke ovens. When another method of increasing activity is also adopted—such as slight undercarbonizing—the additional effect of alkali activation is more marked than under normal carbonizing conditions.

The application of these conclusions to the production of a reactive open-grate coke, so far as the investigation has gone at the present time, may be summarized as follows. With the more reactive coals it should be possible by alkali activation to make reactive cokes in vertical or horizontal retorts, and possibly even in coke ovens, under normal carbonizing conditions, provided the coke is not over-coked. With less reactive coals of higher rank, alkali activation in vertical retorts should give the required reactive coke under normal conditions, but in horizontal retorts and in coke ovens some additional means of increasing reactivity will probably be necessary. The two obvious methods are (1) undercarbonizing and (2) blending. Of these only the former has, so far, been investigated in conjunction with alkali activation, and the results of this work will be given in later contributions to this discussion.

There is one thing which will materially assist the application of alkali activation. That is the production of cleaner coals. It must be admitted that alkali activation inevitably increases the ash content of a coke. In order to produce a coke of not more than 6% ash it is necessary, where alkali activation is used, to start with a coal of not more than 3% ash. With modern improvements in coal washing this can be done, and in future, I hope, will be done, at a relatively low cost. In this respect the proposal made by E. S. Grumell* for the fractionation of coal to give a low ash fraction for carbonization, and a higher ash fraction for power raising, should have an important application.

Although the phenomenon of alkali activation has been known for a long time, the attempt to apply it in the carbonizing industries is very recent. Inevitably there are points which require further investigation before they can be regarded as satisfactory, such as the best method of feeding alkali and securing adequate mixing with the coal. There is also the vexed question of the effect of alkali on the life of refractories. I do not think that this is likely to be as serious as some people suggest, but the only satisfactory test is a prolonged trial in a retort or coke oven. Since the introduction of high silica refractories the danger due to salt in coals has become negligible, and there does not seem to be any evidence that alkali should be more dangerous than salt. There is, in fact, reason to believe that it should be less dangerous.

When these difficulties are overcome, and there seems no reason why they should not be overcome, alkali activation in some cases alone, in others in conjunction with other methods of increasing the reactivity of coke, should provide a real solution of the problem of preparing a satisfactory free-burning coke by carbonization in gas retorts or coke ovens.

What is the cost of this process likely to be? If we assume 0·5% sodium carbonate and 1% lime on the coal are necessary, the cost, including mixing, should be about 1·3s. per ton of coal or about 1·8s. per ton of coke. If 1% of sodium carbonate is necessary, as it may be in the case of coke ovens, the cost will be about 2s. to 2·5s. per ton of coke. If clean coal is used the cost of cleaning will to some extent be offset by the decrease in the lime required. When the advantages of a reactive coke are considered this does not seem a high price to pay. There is little doubt in the minds of most people that there is a big market waiting for a cheap, free-burning, open-grate coke, and I should like to urge on the carbonizing industries the serious consideration of the process of alkali activation which I have briefly described.

* Trans. Inst. Min. E., 1934, lxxxvii., 260–267.

The Production of Reactive Coke in Coke Ovens

By Dr. R. A. MOTT

The part which the Midland Coke Research Committee has played has been essentially to test, on a semi-large scale, the laboratory tests of I.C.I. (Alkali) Ltd., reported by Mr. P. J. Askey, and to assess the value of the cokes so produced in domestic grates. Since the assessment of the value of the cokes is perhaps of greatest importance, I will deal with that first.

The Qualities Required in an Open Grate Coke.

The Midland Coke Research Committee has been carrying out work on the use of oven coke in a domestic grate for several years which has enabled the following conclusions to be made:

(1) Any oven coke can be ignited with gas and will burn up to give a "bright fire," if the size of the coke is restricted to 1 to 1½ in. sq. mesh.

(2) Only the more reactive oven cokes (C.A.B. under 0·055) could be used of 1½ to 2 in. size in a domestic grate. The larger the size of coke used the less regular and the pleasanter was the appearance of the fire.

(3) Coke of under 1 in. size offers a considerable resistance to the passage of air and, even if reactive, burn at a slow rate because of the low draught available.

Although any oven coke, even the most unreactive beehive coke, would, by selecting a suitable size, give a hot and intense fire, it does not follow that the general public would accept it as a suitable substitute for coal. The qualities which are essential in an open grate coke are: (1) That it should be readily ignitable; (2) that it should give a bright fire quickly; (3) that it should give a pleasant fire; and (4) that it should not impose undue attention in use over a prolonged period.

Ordinary oven coke does not meet these requirements, for it frequently demands an intense ignition which would be unduly expensive, and could not be given by the amount of paper and sticks which could conveniently be used. The time required to give a bright fire for coke of standard size was found to be related directly to the specific reactivity of the coke as measured by the critical air blast test (C.A.B.) of the Northern Research Committee, with the modification of the standard of ignition described in the *Gas World*, 1935.* A hot intense fire is not a pleasant one. The pleasantness of a coal fire is due to radiation from surfaces which are at a very high temperature, alternating with surfaces which are black and cool. This variety can only be obtained by using large sizes of fuel (up to a maximum of about 3 in.). Since it was found that a large size of coke could only be used if the specific reactivity of the fuel was high (low C.A.B.), the essential requirements of a coke which is suitable as an open grate coke is that it should be sufficiently reactive (C.A.B. sufficiently low). A low C.A.B. means easy ignition, rapid burning up to a bright fire, and flexibility or ability to use a range of size of fuel which will give a pleasant fire. The ability to use a range of sizes, say, 1 to 3 in., means that at any moment in the history of a fire there will not be the large concentration of small material which restricts passage of air and makes it burn too slowly.

H. J. Hodsman and his collaborators† have stated that the bulk density is one of the most important factors governing the behaviour of coke in an open grate. Experimental work has shown that it takes approximately 5 min. per 1 lb. of fuel of 1½ to 2 in. size, if not too unreactive, to attain a bright fire after ignition. On this basis the time taken by a charge of 0·5 cu.ft. of fuel to attain a bright fire would be as follows:

Bulk Density, Lb./Cu.Ft.	Time to Bright Fire (Min.).	Time for Bright Fire to Extinction (Hr.).
15	37½	3·3
20	50	4·4
25	63½	5·5
30	75	6·6

Thus cokes of low bulk density will necessarily attain a bright fire the soonest, assuming that the specific reactivity does not vary much. On the other hand, assuming that the rate of combustion required is 2·25 lb. of fixed carbon per

* Coking Section, Jan. 5 (Fig. 1).

† Communication No. 80, Inst. Gas Eng., 1933.

hour, the figures in the third column show that the fires from cokes of low bulk density will require refuelling the most frequently. Even the most reactive of low-temperature cokes give the best performance if undisturbed, for poking to remove ash before refuelling exposes partly-burned surfaces on which ash is apparent and which do not look well. A balance between low bulk density to give a bright fire sufficiently quickly, and high bulk density which enables a fire to last longer, is therefore desirable.

The Production of Reactive Cokes in Coke Ovens.

The tests were made in an experimental coke oven which has already been described.* It was 18 in. wide, 3 ft. long, and 2 ft. 7½ in. high, taking a charge of about 400 lb. of coal. The oven was heated with coke oven gas at the sides and the coking time could be controlled by varying the gas pressure which would then be maintained by the use of a suitable governor.

Two series of tests were made, one with a washed slack of 7·0% ash and coal from the same source (Parkgate and Silkstone Seams, South Yorkshire) of 2 to ⅛ in. size specially cleaned in calcium chloride to 2·0% ash. The coal was crushed so that 75 to 80% passed ⅛ in., the alkali was added by sprinkling over the surface and the charge turned over several times by hand to obtain a uniform mixture. The moisture content was kept at a low value to enable the bulk density of the coal in the oven to approximate to that of a charge in large-scale coke oven practice. The charge was added to the oven from a hopper, and after coking for the desired time, was raked out by hand and quenched. In the first series of tests the tar and liquor were condensed and weighed and the gas measured by means of a calibrated orifice meter, the calorific values being determined by a Jones-Miller gas calorimeter.

Series I.—The results of the first series of tests may be summarized as follows. The addition to coal before carbonizing of 0·5 to 1·0% of sodium carbonate with a suitable amount of lime (about 2·0%) reduces the C.A.B. of fully carbonized charges by about 0·014, the addition of 5% of sodium carbonate alone reducing the C.A.B. by 0·020. The addition of sodium carbonate by the immersing of hot coke made from straight coal in a suitable solution of sodium carbonate to give 1·23% in the coke (equivalent to 0·85% in the coal) only reduced the C.A.B. by 0·003. The use of small amounts of sodium carbonate gave an increased thermal yield of gas of about 5%, which rose to 10% when the addition of sodium carbonate was 5%. The tar yield is reduced when alkali is mixed with the coal.

Series II.—The second series of tests was made with coal containing only 2·0% ash which required 0·5% of $Ca(OH)_2$ to saturate its silica and alumina. The ash content of the coke made from the straight coal was 3·75% and 6·5% when 0·75% of hydrated lime and 1·0% of sodium carbonate was carbonized with the coal. The coal was fully coked in 14 hours. The effect of overcoking and undercoking is shown in Table 1.

TABLE 1.—*Effect of Coking Time (Addition of 0·75% Ca (OH)₂ 1·0% Na_2CO_3 to Coal).*

—	Test No.	—	C.A.B.	Yield + ½ In Coke.*	V. Mtr. + ½ In. Coke.	1–1½ In. Coke.		1½–2 In. Coke.	
						Gas for Ignition (Cu.Ft.).	Time to Bright Fire (Min.).	Gas for Ignition (Cu.Ft.).	Time to Bright Fire (Min.).
Coal alone	16	Overcoked 1 hr.	0·064	71·1	0·8	22·0	97	29·0	86
	17	Fully coked	0·059	70·8	1·3	14·2	86	22·0	74
	22	Undercoked 4½ hr.	0·054	76·6	1·8	16·8	85	25·6	73
Coal with alkali	18	Fully coked	0·045	70·9	2·9	15·0	70	16·8	55
	19	Undercoked 1½ hr.	0·042	69·5	2·8	11·5	64	16·0	54
	20	Undercoked 3 hr.	0·040	67·9	3·1	9·0	73	9·7†	(85)†
	21	Undercoked 4½ hr.	0·032	63·8	3·8	7·1	63	12·4	55
			Bulk density, lb./cu.ft.			25-26		22·5–25	

* The yield is alkali-free dry coke on alkali-free dry coal. † Minimum ignition given in error.

The alkali reduces the C.A.B. of a fully coked charge by 0·014 and of a charge undercoked 4½ hr. by 0·022. When a charge is drastically undercoked by 4½ hr., the amount of salable coke (yield + ½ in.) decreases, but undercoking by only 1½ hr. gives only a small loss of yield.

By progressively reducing the C.A.B. the gas required for ignition of a charge in an "Eagle" grate is reduced. The gas for ignition must be considered in conjunction with the time to attain a bright fire. For cokes 1 to 1½ in. size the minimum ignition was given, that is least amount (as judged by experience) which would enable the fire to pick up. The time to bright fire is, therefore, longer than if the ignition had been more intense. For coke of 1½ to 2 in. size, the "maximum ignition" was given, this being judged to be the amount beyond which an acceleration in pick-up was not expected.

When the amount of hydrated lime and sodium carbonate added was reduced to 0·5% of each, and the coke was undercarbonized by 4½ hr., the C.A.B. was 0·038 (that is 0·5% sodium carbonate reduces the C.A.B. by 0·016 compared with 0·022 with 1%). On reducing the flue temperatures to obtain a fully coked charge in 19 hr., and under carbonizing a charge containing 0·75% hydrated lime and 1·0% sodium carbonate, the C.A.B. was 0·032; the yield + ½ in. was 63·6 as low as for under carbonizing by 4½ hr. on a 14 hr. schedule.

The lowest gas for ignition is required for coke of 1 to 1½ in. size, but a larger size is necessary for continued use. Sizes of 1½ to 2 in., 2 to 2½ in., and 2½ to 3 in. were burnt in an ordinary well grate and gave very pleasant fires. With the smaller amount of surface exposed, the rate of combustion was reduced. For under coked alkali-activated coke the mean rate of combustion is about 2·4 lb. of fixed carbon per hour for 1 to 1½ in. size, 2·35 for 1½ to 2 in. size, and falling to about 2·0 lb. for coke of 2½ to 3 in. size. The ability to use these sizes satisfactorily is entirely due to activation, for the straight coke could not be used in a size larger than 1½ to 2 in. The ability to use the larger sizes enables the quality of a fire to be altered according to circumstances and gives flexibility not only in the use of the coke, but also in the preparation of suitable sizes by the producer. Mixtures containing various proportions of the different grades within the range 1 to 3 in. were tried and gave a performance almost as good as that of 1½ to 2 in. alone. The high rate of combustion of alkali-activated cokes enables a small fire to be used if desired.

Tests were made on the ignition of the activated cokes with paper and sticks. Coke No. 23 (C.A.B. 0·032) of 1 to 1½ in. size, required 8 oz. of sticks to give a bright fire in 60 min., compared with 6·2 cu.ft. of gas to give a bright fire in 58 min. Coke No. 24 (C.A.B. 0·038) required 12 oz. of sticks to give a bright fire in 65 min. (compared with 56 min. when 10·6 cu.ft. of gas were used). Cokes of C.A.B. 0·042 to 0·045 required 12 to 16 oz. of sticks to give a bright fire in under 60 min. The calorific value of sticks is about 500 B.Th.U. per oz., and the amount of gas in cu.ft. is approximately equal to the ounces of sticks required for ignition. A coal fire will require about 8 oz. of sticks, so that for the less reactive cokes a rather heavier charge of sticks is necessary. With sticks at ¾d. per 18 oz. bundle, a coal fire would cost 3s. 8d. for lighting, and a coke with a C.A.B. of 0·042 would cost about 0·5d., for which one could use 15 cu.ft. with gas at 3s. per 1,000 cu.ft. For comparison one may record that a low-temperature coke of C.A.B. 0·020, 1½ to 2 in. size, with a bulk density of only 10 lb./cu.ft. required 5·3 cu.ft. of gas for ignition and gave a bright fire in 35 min. A high grade house coal of bulk density 40 lb./cu.ft. required 10·6 cu.ft. of gas to give a bright fire in 73 min. Although the alkali-activated oven cokes do not give such ready ignition as do low temperature cokes, their greater density, their hardness which prevents their crumbling in the fire like low-temperature cokes, give a more permanent fire which many consider to be pleasanter. A fire of 1½ to 2 in. size will give yellow (sodium) flames burning above the fire, but with larger sizes the amount of flame is small.

Thus it is possible to manufacture in a coke oven, by alkali addition and under-carbonization, an open grate coke which could be ignited as easily as coal, but not quite so readily as low-temperature coke. If one under-carbonizes less drastically, a fuel is obtained which while requiring a more powerful ignition is flexible in use and gives a pleasant

* "Coke for Blast Furnaces," London, 1930.

fire. Although further tests are required in confirmation, it may prove the most satisfactory to the coke maker to use 0·5, 0·75, or 1·0% of sodium carbonate with low ash coal which would require addition of about 0·5% of hydrated lime, and to undercarbonize for about 1½ hr. The period of undercoking will depend on the normal coking time, but fast coking appears to produce the smallest amount of breeze when a charge is undercoked.

The Production of Domestic Coke in Gas-Works

By H. H. THOMAS, of the Liverpool Gas Company

A graded coke which ignites easily and burns freely in an ordinary well grate has been made by the Liverpool Gas Company since 1930. The object of the original experiments was to produce a fuel which did not require the use of a special grate, and that this has been attained is indicated by the sales, which were 1,184 tons in 1931 and 16,773 tons in 1935. It has been given the registered name of "Dryco," to distinguish it from ordinary coke, is graded ⅜ in. × 2 in. and delivered in 1 cwt. sealed bags at 2s. 2d.

This fuel is produced by carbonization at high temperature; in the early stages of its manufacture the coal used was a mixture of coking and non-coking slacks carbonized in horizontal retorts, the coke being dry cooled in a Sulzer plant. It was soon seen that the capacity of the blending, carbonizing, and cooling plant would be too small to meet the demand, and experiments were continued in vertical retorts. It is well known that vertical coke is normally more combustible than that from horizontal retorts, due to the types of coal used and the carbonizing conditions. The normal vertical retort coke which was being made at that time was not, however, equal to the blended "Dryco" either in ease of ignition or combustibility. A satisfactory fuel was produced by selection of coal and careful control of carbonizing conditions.

The coals found to be most suitable are medium coking and practically non-swelling and the resultant coke is equal to the orginal blended coke in ease of ignition and combustibility.

Suitability for Domestic Use in Ordinary Grates.

The test used to determine the properties of the experimental cokes were made in an open grate.* In the first experiments a "Metro" grate with gas burner ignition was used and this has been retained throughout. Although the coke was intended to burn in any grate, the use of a special coke grate was decided upon so that a constant gas ignition effect could be applied, and to enable the more incombustible cokes to be burned for comparative purposes.

A domestic coke must be easily ignited and the standard which was set was a maximum of 4 cu.ft. of gas to be used to light the fire; after ignition, thermopile readings of the radiation were taken at intervals of 15 min., the fire being replenished after two hours and again after 1½ hours; the fire was not disturbed apart from the addition of fuel.

This method of test is essentially practical and with a standardized method of procedure enables the value of a fuel to be determined. Experience with this method soon proved that ease of ignition is a reliable indication of the properties of a coke and the decision as to which fuels are to be sold as "Dryco" is largely determined by this test. Recent collaboration with Mr. Askey has shown that the critical air blast gives an accurate indication of the open grate performance of a fuel, and this test is now being used to obtain a rapid measure of the reactivity of a fuel. A C.A.B. of 0·04 cu.ft. per minute is the figure which must be attained with a domestic fuel.

Manufacture and Control of Coke Quality.

There is a definite limit to the control which can be exercised over the quality of a domestic fuel produced on a large scale, in fact it has been stated by a competent authority that some of the desirable properties are mutually incompatible.

The moisture is kept low by dry cooling. The character of the ash cannot be controlled and it will often be found that a suitable coal often contains an evenly distributed and finely divided ash, probably low in quantity, which adheres to the resultant coke in the fire giving a dirty appearance and obscuring the radiation.

A low ash content in the coke can only be maintained by selection of the coal. It should not exceed 7%, particularly if it is finely divided; a higher percentage of a heavy granular ash is not nearly so objectionable.

The bulk density depends upon the type of coal used and the conditions of carbonization. It has been stated that this property affects the combustibility, and although the density of "Dryco" is 21·3 lb. per cu.ft. we have no proof that it is impossible to produce a combustible fuel which has the texture of horizontal coke. The low density of these cokes increases handling costs, lowers the strength and necessitates more frequent replenishment of a fire.

The volatile content depends upon the heat treatment—*i.e.*, a combination of time of carbonization and temperature. Published figures show that the ignition time varies with the volatile content, but in our view this figure should be considered simply as a measure of the heat treatment which a coke has received: a low V.M. does not always indicate a low combustibility.

Large-scale experiments at Liverpool have proved that high temperature has a greater effect than increased time of carbonization on the combustibility of the coke. In the gas-making process it is necessary to know the effect of the conditions selected on the gas output and the thermal yield. Residual volatile matter in the coke represents lost thermal yield, and this factor is of great importance.

Normal "Dryco" contains approximately 2 to 3% V.M. and the carbonizing conditions used result in some reduction in thermal yield, but give in increased coal throughput. The financial return from the process is greater owing to the increased value of the coke. While we shall continue to use our present methods in Liverpool, it must be admitted that the process cannot supply a national demand; the capacity of the gas-making plant determines the output and the supply of suitable coals is limited.

The alkali activation of coke suggested by Prof. Cobb and Mr. Hodsman and developed more recently by Imperial Chemical Industries is worthy of investigation; the advantages of this process are apparent to everyone connected with the carbonizing industries. It will enable a domestic fuel to be produced from any coal in all types of carbonizing plant. The modification by Mr. Askey of the original suggestion substitutes part of the sodium carbonate with lime; this has the double advantage of reducing the cost of the treatment and also the amount of inorganic matter to be added to the coke.

The carbonization of normal gas-making coals would produce a more dense coke and enable the thermal yield and output to be maintained and possibly increased. The effect of the small quantity of sodium carbonate on the refractory material will have to be determined over an extended period, and this is now being done. The experiments which have been made indicate that the increase in combustibility obtained in both horizontal and vertical retorts is in some cases more than sufficient to bring the coke into the domestic fuel market.

Test charges have been carbonized in horizontal and vertical retorts. The charges were carbonized in horizontal retorts, using a charge of 4¼ cwt. of a Yorkshire gas coal. The alkali was mixed by hand and the coal was graded to determine the intimacy of mixing obtained with varying particle size. The first tests were made at normal carbonizing temperatures, and while there was an improvement in the reactivity, this was not sufficient to bring the coke to the level of "Dryco."

In later tests the carbonizing conditions were modified by a reduction in the setting temperature to give a retort wall temperature of about 930° C. compared with a normal 965° C., alternatively, the coking time of eight hours was reduced by ½ ± ¼ hour. The effect of such a reduction on the thermal yield cannot be considerable and would be compensated by the increased value of the coke. In any case it has been reported that an increase in thermal yield is obtained by alkali activation. This has not been confirmed with the quantity of alkali used in the experiments at Liverpool, but the test was not conclusive.

Experiments in Vertical Retorts.

In these tests the difficulty has been to ensure adequate mixing; so far a satisfactory method for experimental purposes has not been found. The alkali has been added to the coal falling into the bunker from the conveyor, but adequate mixing does not always take place, and the alkali contents of the cokes has varied widely.

Normal vertical coals which are not used for the production of "Dryco" have been activated to a C.A.B. of 0·036 under normal carbonizing conditions when the necessary percentage of alkali was present.

Alkali addition to a "Dryco" coal produced a coke with a C.A.B. of 0·032 which was lighted with 2 cu.ft. of gas in the fire test and burned very freely, in fact it was too combustible and burned away too quickly.

So far as gas undertakings are concerned, it would appear that treatment in vertical retorts has shown most promise to the present time. The value of the method in large-scale vertical retorts has been confirmed, whereas the horizontal

* Brown, "JOURNAL," Vol. 190, p. 92.

charges were carbonized in a test plant where the carbonizing conditions differ slightly from those in works plant.

The question of the effect of the added alkali on the refractory will have to be determined by experiments over a period of at least 12 months, and this is being done. Apparatus has been installed on a vertical retort which enables mixed alkali to be added in proportion to the flow of coal. Analyses of the coke do not indicate that the degree of mixing desired is being obtained, but the alkali addition is continuous, and modification of the machine will be made to give the required conditions. The retort will then be compared with others working under similar conditions without alkali addition. This point is most important, and it may be that sodium carbonate has little effect upon the refractory; the corrosive effect of salt is well known, but it is not possible to conclude that sodium carbonate will be equally so.

The conclusions may be summarized as follows:

(1) Increase in reactivity sufficient to produce a domestic fuel can be obtained by the addition of lime and soda to the coal before carbonization.
(2) It is necessary to have the required quantity of lime present: this has been found to bear a definite relation to the percentage of ash in the coals which have been used, and the alkali is added in proportion to the ash percentage.
(3) Sodium carbonate equivalent to ½% on the coal weight is then sufficient to give the required increase in activity.
(4) The alkali must be intimately mixed with the coal.
(5) Calcium carbonate is equally effective as calcium hydrate calculated as CaO.
(6) The reactivity of an alkali activated fuel is quickly reduced by excessive heat treatment.
(7) Cokes have been made in horizontal retorts with a C.A.B. of 0·038 from a strongly coking gas coal when a blank under similar conditions had a C.A.B. of 0·058. The fire test confirmed the C.A.B., the activated fuel was lighted with 4 cu.ft. of gas, burned up well, and recovered quickly after refuelling.
(8) The most consistent results have so far been obtained in vertical retorts with normal coals and carbonizing conditions.

The results obtained are most encouraging, and there is no doubt that the method can be used to increase the production of free burning domestic fuel with the high temperature carbonizing processes used by the Gas Industry.

The study of this subject has been encouraged during a long period by Mr. R. E. Gibson, Chief Engineer of the Liverpool Gas Company, and I am indebted to him for permission to make these notes.

Scottish Western Juniors

Visit to Alder & Mackay's New Grange Works

Members of the Scottish Junior Gas Association (Western District) inspected the New Grange Works of Messrs. Alder & Mackay, Ltd., on Saturday, Nov. 28.

In the press shop, which is divided from the tool room by a wire partition, the members saw index frames, pointers, diaphragm pans, breeches, ash trays, &c., being stamped or drawn. In the tool room a universal grinder was seen in operation. In the index shop, two "Mikron" hobbers were working, along with a "Koepfer" worm cutter, and a "Boley" 10-spindle drill; riveting machines, index assembly and attachment assembly also were seen in this department.

Prepayment valves, covers, and gratings were seen in course of production in the white metal shop, and the rough and finish lapping was also demonstrated. In the paint shop, spray painting at a pressure of 70 lb. per sq.in. is carried on, and in the leather department an electric sewing machine was demonstrated, along with the processing of leathers and the fitting of leathers into pans. Casemaking and "bellowsing" along with gas proving for initial tests were shown, and valve grinding, fitting, indexing, and proving were explained in their respective departments.

In the wet meter department a drum was shown in the making and the proving of a meter with a glass front was also an exhibit. In the drawing office, printing of white prints was shown by an arc lamp process, and on the same floor, in the upper brass shop, automatic lighters and prepayment attachments were in process of assembly.

A moulding machine working at 750 lb. per sq.in. was in operation in the foundry, along with a gas furnace. The mechanical hammer in the smith's shop was working, and in the boring shop a "Pollard" multi-spindle machine and a "Jackman" grinder were demonstrated. The automatic room was also visited, and here was seen a No. 00 "Brown and Sharpe" full automatic at the speed of 5,000 r.p.m. A 1S "Herbert" capstan lathe was also shown in operation at a speed of 4,000 r.p.m.

After the inspection of the works the visitors were entertained at tea in the Royal British Hotel, Princes Street, Edinburgh, when Mr. J. L. Bennet, Director, welcomed the visitors, and expressed the pleasure it had given his Company to have had the Western Juniors at their works that afternoon and as their guests that evening.

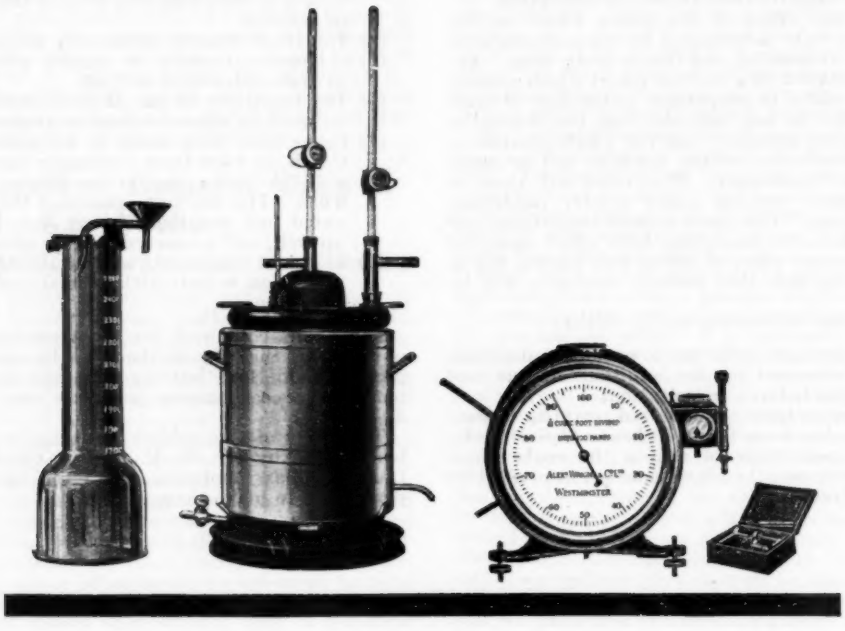
Those who had been there before would have noticed changes and those who had seen their works for the first time he hoped would have formed a desire to come and see them again. He would also like to express the pleasure they had at seeing some of the senior members of the Industry who had graduated in that splendid university—the hard school of experience—present that afternoon. Continuing, Mr. Bennet said that unavoidable circumstances had prevented Councillor W. Muter, the newly elected Convener of the Public Utilities Committee, and Mr. J. Jamieson, General Manager of the Edinburgh Gas Department, from being present. He asked Mr. Melvin, Assistant Engineer and Manager, to convey to Mr. Jamieson his thanks for the efficient and cheap gas service which they had. They had also with them to-day Mr. James Morrison, late of Calcutta; he was an example of the progress that can be made from the junior ranks of the Gas Industry, because, starting as a bench hand, he had worked himself up to one of the highest positions on the distribution side of the Oriental Gas Company in Calcutta.

Small High-Capacity Meter.

Probably the most interesting development in meters since the visitors were there last was the introduction of the small high-capacity meter. When the 100 cu.ft. per hour size first came out, it was tested first of all at 8 revolutions to the foot, and then the speed was increased to 10 revolutions to the foot, making 1,000 revolutions per hour. Since then results gained on test have shown that the "Small" high-capacity 100 cu.ft. per hour meter is a satisfactory and dependable job, and that there is nothing to be afraid of in running it at its rated capacity. It would have been noticed that in three of their shops they had machines for their own production purposes running from 4,000 to 5,000 revolutions per minute, so that they did not look upon speed in itself adversely. At the same time he would like to mention that a meter of this type was not intended to run constantly at its maximum capacity, 100 cu.ft. per hour. In gas meters, as in all plant, a margin for overload should always be allowed, and, of course, as they were all aware, the overloading of any meter puts it outwith the guarantee. The guarantee is given on the understanding that meters would not be overloaded, but apart from the guarantee, for their own peace of mind it was advisable to choose meters for any job with an overload of 25%, which still kept the maximum quantity per hour of the meter within its badged capacity.

In concluding, Mr. Bennet hoped that what they had seen in the works that afternoon would have been of benefit to all and would have proved to them the care with which meters are made.

Mr. J. Webster, Port Glasgow, President, asked Mr. Bennet to convey to his Board the warmest thanks of the Association for the privilege that they had had that afternoon and for the generous hospitality which they had also provided. A gas meter was undoubtedly a scientific instrument, and that the quality of A. & M.'s products stood high in the Industry. He was very much impressed with the production methods and congratulated the Directors on evolving such a highly efficient system of working. Mr. Webster made reference to the "A. & M" advertisements, which were, in his opinion, enlightening and enlivening. Before concluding, he wished to mention the firm's popular representative, Mr. P. Blackhall, and said that a firm was often judged by their representative, and that in this case both were held in high esteem. He would again like to express his thanks to the firm for the most enjoyable and instructive afternoon which they had had.



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Gas Markets and Manufactures

Stock Market Report

(For Stock and Share Lists, see later pages)

International politics were again the dominant factor in Stock Exchange affairs, and prices in most sections last week showed considerable fluctuation. At the commencement of business the Sunday Cabinet meeting cast a gloom over markets, though a partial recovery set in after Mr. Eden's statement in the House of Commons. Then followed rumours of trouble between Germany and Russia which led to a big selling movement from Paris. Later, however, the atmosphere cleared somewhat, prices began to recover, and the week closed on a more hopeful note. Gilt-edged securities were fairly firm throughout, while the demand for home and foreign rails continued. Industrials suffered considerably at one time, but later became buoyant and in many instances almost reached their former levels, a number of satisfactory reports being responsible for some strong features. Oils reacted on Paris selling, though here again the recovery was nearly complete by Friday. The week certainly kept speculation within bounds and gave the permanent investor an opportunity of "getting in" at slightly lower levels.

In common with other high-class investment issues, Gas stocks and shares weathered a stormy week in good style. There was no falling off in the demand and prices on the whole were well maintained. The only change of note was a setback in Imperial Continental, which fell a further 6 points to 149½, and having regard to the political situation and the almost panicky state at one time of the Paris Bourse this reaction appears unavoidable, though any improvement in the conditions abroad should bring about a prompt recovery in the present price.

Portsmouth and Gosport ordinary, which it will be remembered hardened 7 points a week ago, rose a further point to 178-183, business being recorded at the top price, and the Company's 5% maximum stock gained a similar amount to 114-119; British ordinary also hardened 1 to 157-162. At the Provincial Exchanges, a parcel of Bristol ordinary changed hands at 118, which brought down the quotation 2 points to 119, while at Newcastle the Hartlepool Company's consolidated stock improved 1 to 126, and the local Company's 4% preference rose a like amount. In the Supplementary List the nominal quotation of York consolidated was marked up 7 points to 120½, though business was recorded at 113 only.

Current Sales of Gas Products

The London Market for Tar Products.

Nov. 30.

There is little change to report in the prices of Tar Products, which are as follows:

Pitch nominal at about 34s. per ton f.o.b.
Creosote, about 5¾d.
Refined tar, 3¾d.
Pure toluole, 2s. 4d.; pure benzole, 1s. 7d. to 1s. 8d.; 95/160 solvent naphtha, about 1s. 7d.; and pyridine has advanced still further, the price for 90/160 being about 7s. All prices are per gallon naked at makers' works.

Tar Products in the Provinces.

Nov. 30.

The average prices of gas-works products during the week were: Gas-works tar, 18s. 3d. to 23s. 3d. Pitch—East Coast, 31s. to 33s. f.o.b. West Coast—Manchester, Liverpool, Clyde, 31s. to 33s.* Toluole, naked, North, 1s. 11d. to 2s. Coal tar crude naphtha, in bulk, North, 8d. to 8½d. Solvent naphtha, naked, North, 1s. 4d. to 1s. 5d. Heavy naphtha, North, 1s. 1½d. to 1s. 2½d. Creosote, *ex* works, in bulk, North, liquid and salty, 4¾d. to 5d.; low gravity, 4½d. to 4¾d. Heavy oils, in bulk, North, 5d. to 5¼d. Carbolic acid 60's, 2s. 7d. to 2s. 8d. Naphthalene, £18 to £20. Salts, 90s. to 95s., bags included. Anthracene "A" quality 4½d. to 4¾d. per minimum 40% purely nominal; "B" quality, unsalable.

* All prices for pitch are now quoted on the basis of f.o.b. In order to arrive at the f.a.s. value at any port it will be necessary to deduct the loading costs and the tolls whatever they may be.

Tar Products in Scotland.

GLASGOW, *Nov.* 28.

Conditions are rather quiet, although some movement in creosote oil has taken place during the week.

Crude gas-works tar.—The actual value is 34s. to 35s. per ton *ex* works in bulk.

Pitch is not moving as it should at this season and prices are easy at 30s. to 32s. 6d. per ton f.o.b. Glasgow for export, and 30s. per ton *ex* works in bulk for home trade.

Refined tar remains unchanged at 3d. per gallon f.o.r. for export, and 3¾d. per gallon *ex* works in buyers' packages for home trade.

Creosote oil.—Some railway business has been fixed during the week which has had a steadying influence on the market. Values are as follows:—Specification oil 4¾d. to 5d. per gallon; low gravity, 4¾d. to 5d. per gallon; neutral oil, 4½d. to 4¾d. per gallon; all *ex* works in bulk.

Cresylic acid.—Only a small business is being conducted and values remain nominal as follows:—Pale, 97/99%, 2s. 4d. to 2s. 6d. per gallon; dark, 97/99%, 2s. 1d. to 2s. 3d. per gallon; pale, 99/100%, 2s. 9d. to 3s. per gallon; all *ex* works in buyers' packages.

Crude naphtha.—Available supplies are small and command 5½d. to 6d. per gallon *ex* works in bulk, according to quality and district.

Solvent naphtha is not too active, with prices unchanged at 1s. 4½d. to 1s. 5d. per gallon for 90/160 grade, and 11d. to 1s. per gallon for 90/190 heavy naphtha.

Motor benzole continues to be valued at 1s. 2½d. to 1s. 3d. per gallon.

Pyridines are scarce in this district, with 90/160 grade valued at 6s. to 6s. 6d. per gallon, and 90/140 grade at 7s. to 7s. 6d. per gallon.

Benzole Prices.

These are considered to be the market prices for benzole at the present time:

	s.	d.		s.	d.	
Crude benzole . . .	0	8½	to	0	9	per gallon at works
Motor ,, . . .	1	2	,,	1	2½	,, ,, ,,
90% ,, . . .	1	3	,,	1	3½	,, ,, ,,
Pure ,, . . .	1	7	,,	1	7½	,, ,, ,,

Contracts Advertised To-Day

Condensers.

Belfast Gas Department. [p. 688.]

Gasholder.

Belfast Gas Department. [p. 688.]

Generating Set.

Belfast Gas Department. [p. 688.]

Lead Gas and Water Piping.

Stockport Gas Department. [p. 688.]

Pipes and Fittings.

Ripon Gas Department. [p. 688.]
Stockport Gas Department. [p. 688.]

Retort Installation, Vertical, &c.

Stockport Gas Department. [p. 688.]

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Official Quotations on the London Stock Exchange

Issue. £	Stock or Share	When ex-Dividend.	Dividends. Prev. Hf. Yr. % p.a.	Dividends. Last Hf. Yr. % p.a.	NAME.	Quotations Nov. 27.	Rise or Fall on Week.	Transactions, Lowest and Highest Prices During the Week.
1,767,439	Stk.	Sept. 7	7⅞	8	Alliance & Dublin Ord. ...	167—172	...	168½
374,000	,,	June 22	4	4	Do. 4 p.c. Deb. ...	94—99	...	...
557,655	,,	Aug. 10	7	7	Barnet Ord. 7 p.c.	168—173	...	171—172
300,000	1	Oct. 5	1/9⅞	1/4⅛	Bombay, Ltd.	26/—28/-	...	27/7½
179,305	Stk.	Aug. 10	9½	9½	Bournemouth sliding scale ...	220—230	...	225—230
590,407	,,	,,	7	7	Do. 7 p.c. max. ...	168—173	...	...
493,960	,,	,,	6	6	Do. 6 p.c. Pref. ...	148—153	...	151—152½
50,000	,,	June 22	3	3	Do. 3 p.c. Deb. ...	85—90	...	...
262,025	,,	,,	4	4	Do. 4 p.c. Deb. ...	105—110	...	...
335,000	,,	,,	5	5	Do. 5 p.c. Deb. ...	125—130	...	...
357,900	,,	Aug. 10	7½	7½	Brighton, &c., 6 p.c. Con. ...	168—173	...	...
649,955	,,	,,	6½	6½	Do. 5 p.c. Con. ...	153—158	...	156½
205,500	,,	,,	6	6	Do. 6 p.c. 'B' Pref.	145—150	...	149
855,000	,,	Oct. 5	8	7	British Ord.	157—162	+1	160
100,000	,,	June 8	7	7	Do. 7 p.c. Pref.	151—156	...	...
350,000	,,	,,	5½	5½	Do. 5½ p.c. 'B' Cum. Pref.	108—113	...	...
120,000	,,	,,	4	4	Do. 4 p.c. Red. Deb. ...	95—100	...	...
450,000	,,	,,	5	5	Do. 5 p.c. Red. Deb. ...	110—115	...	...
200,000	,,	,,	3½	3½	Do. 3½ p.c. Red. Deb. ...	100—103	...	...
100,000	10	22 May '33	6	4	Cape Town, Ltd.	1—3	...	...
100,000	10	6 Nov.'33	4½	4½	Do. 4½ p.c. Pref. ...	1—3	...	39/-
150,000	Stk.	June 22	4½	4½	Do. 4½ p.c. Deb. ...	80—85	...	...
626,860	,,	July 20	6	6	Cardiff Con. Ord.	128—133	...	...
237,860	,,	June 8	5	5	Do. 5 p.c. Red. Deb.	108—113	...	...
98,936	1	Oct. 19	2/-	2/-	Colombo Ord.	1⅜—1½	...	...
24,510	1	,,	1/4½	1/4½	Do. 7 p.c. Pref. ...	23/6—25/6	...	...
609,204	1	Oct. 5	-/11·48	-/11·48	Colonial Gas Assn. Ltd. Ord.	17/6—19/6	...	...
296,053	1	,,	1/3·30	1/3·30	Do. 8 p.c. Pref.	21/—23/-	...	...
1,775,005	Stk.	Aug. 10	5	5	Commercial Ord.	93—98	...	93—95
620,000	,,	June 8	3	3	Do. 3 p.c. Deb. ...	84—89	...	85
286,311	,,	Aug. 10	5	5	Do. 5 p.c. Deb. ...	122—127	...	...
807,560	,,	Aug. 10	7	7	Croydon sliding scale ...	158—163	...	160
644,590	,,	,,	5	5	Do. max. div.	115—120	...	117—118
620,385	,,	June 22	5	5	Do. 5 p.c. Deb.... ...	125—130	...	125
239,000	,,	Aug. 10	5	5	East Hull Ord. 5 p.c.... ...	108—111	...	...
184,555	,,	Aug. 10	6	6	East Surrey Ord. 5 p.c. ...	128—133	...	...
176,211	,,	June 8	5	5	Do. 5 p.c. Deb. ...	123—128	...	...
250,000	1	Nov. 16	4	4	Gas Consolidation Ord. ...	20/6—22/6*	...	...
250,000	1	,,	4	4	Do. 4 p.c. Red. Cum. Pref.	19/—21/-*	...	19/9—20/3
19,284,128	Stk.	Aug. 10	5⅜	5⅜	Gas Light & Coke 4 p.c. Ord.	26/—27/-a	...	26/3—26/9
2,600,000	,,	,,	3½	3½	Do. 3½ p.c. max.	89—92	...	90—91½
4,477,106	,,	,,	4	4	Do. 4 p.c. Con. Pref. ...	105—108	...	106—107½
8,602,497	,,	May 18	3	3	Do. 3 p.c. Con. Deb. ...	86—89	...	86—88
3,642,770	,,	,,	5	5	Do. 5 p.c. Red. Deb. ...	117—120	...	118—120
3,500,000	,,	,,	4½	4½	Do. 4½ p.c. Red. Deb. ...	115—118	...	117—117½
700,000	,,	Sept. 7	...	25/5§	Do. 3½ p.c. Red. Deb. ...	102—104	...	103½
270,468	,,	Aug. 24	6	6	Harrogate New Cons. ...	128—133	...	...
213,200	,,	Aug. 10	6	6	Hornsey Con. 3½ p.c. ...	133—138	...	...
5,600,000	,,	Nov. 12	12	8	Imperial Continental Cap. ...	147—152	−6	148—153½
223,130	,,	July 20	3½	3½	Do. 3½ p.c. Red. Debs.	92—97	...	...
285,242	,	Aug. 24	8½	8½	Lea Bridge 5 p.c. Ord. ...	183—188	...	...
11,751	,,	,,	10	8	Maidstone Gas 5 p.c. Cap. Stk.	190—200	...	...
63,480	,,	June 22	3	3	Do. 3p.c.Prp.Db.Sk.	80—85	...	...
75,000	,,	May 18	†10	†10	Malta & Mediterranean ...	190—200	...	...
392,000	—	Oct. 1	5½	5½	Metropolitan (of Melbourne) 5½ p.c. Red. Deb.	100—105	...	...
231,978	Stk.	Aug. 24	5	5	M.S. Utility 'C' Cons. ...	110—115	...	...
818,657	,,	,,	4	4	Do. 4 p.c. Cons. Pref.	102—107	...	105—105½
360,075	,,	June 22	4	4	Do. 4 p.c. Deb. ...	104—109	...	...
148,955	,,	,,	5	†5	Do. 5 p.c. Deb. ...	122—127	...	...
125,000	—	July 1	3½	3½	Do. 3½ p.c. Rd. Rg. Bds.	97—100	...	...
675,000	Stk.	Nov. 16	†6	16	Montevideo, Ltd.	74—79*	...	77¼—78
225,000	,,	Aug. 10	7½	7½	North Middlesex 6 p.c. Con.	170—175	...	...
396,160	,,	Aug. 10	5	5	Northampton 5 p.c. max. ...	110—115	...	...
300,000	,,	Nov. 2	†7	†9	Oriental, Ltd....	168—173*	...	169—172
416,617	,,	June 8	8	8	Plymouth & Stonehouse 5 p.c.	168—173	...	170
504,416	,,	Aug. 10	8¼	8¼	Portsmouth & Gosport Cons.	178—183	+1	180—183
241,446	,,	,,	5	5	Do. 5 p.c. max. ...	114—119	+1	118
73,350	,	,,	...	5	Do. 5 p.c. Pref. ...	118—123	...	...
363,470	1	Sept. 21	1/-	1/-	Severn Val. Gas Cor. Ld. Ord.	21/6—23/6	...	22/3—23/4½
454,510	1	,,	-/10½	-/10½	,, ,, 4½ p.c. Cum. Pref.	21/—23/-	...	21/9
133,201	Stk.	Aug. 24	5	8½	Shrewsbury 5 p.c. Ord. ...	145—150	...	...
90,000	10	June 8	†3½	†4	South African...	4—5	...	...
1,182,635	1	Sept. 7	1/2½	1/2½	South East'n Gas Cn. Ld. Ord.	27/—29/-	...	...
845,511	1	,,	-/10½	-/10½	Do. 4½ p.c. Red. Cum. Pref.	21/—23/-	...	21/9—22/3
200,000	1	,,	4	4	Do. 4 p.c. Cum. Pref. ...	20/6—21/6	...	...
150,000	Stk.	Aug. 10	...	3½	Do. 3½ p.c. Red. Deb. ...	100—102	...	...
6,709,895	,,	Aug. 10	6½	5	South Met. Ord.	115—118	−1	115½—117½
1,135,812	,,	,,	6	6	Do. 6 p.c. Irred. Pf....	145—150	...	145½—146
850,000	,,	,,	4	4	Do. 4 p.c. Irred. Pf....	104—107	...	105
1,895,445	,,	June 22	3	3	Do. 3 p.c. Deb. ...	87—90	...	87½
1,000,000	,,	July 6	5	5	Do. 5 p.c. Red. Deb.	114—117	...	116—116½
1,543,795	,,	Aug. 10	6	6	South Suburban Ord. 5 p.c....	130—135	...	133—134
512,825	,,	,,	5	5	Do. 5 p.c. Pref....	122—127	...	...
500,000	,,	,,	4	4	Do. 4 p.c. Pref....	102—107	...	...
888,587	,,	June 8	5	5	Do. 5 p.c. Deb....	123—128	...	...
250,000	,,	,,	4	4	Do. 4 p.c. Deb....	102—107	...	...
427,859	1	Nov. 16	1/2⅜	9⅜	S. Western Gas & Water Ord.	21/6—23/6	...	21/9
160,523	1	Oct. 19	-/10¼	-/10¼	Do. 4½% Red. Cum. Pref.	20/6—22/6	...	...
110,000	Stk.	June 22	4	4	Do. 4% Red. Deb. ...	100—105	...	...
647,740	,,	Aug. 10	5½	5	Southampton Ord. 5 p.c. ...	112—117	...	115
121,275	,,	June 8	4	4	Do. 4 p.c. Deb.	100—105	...	...
350,000	,,	Aug. 10	5½	5½	Swansea 5½ p.c. Red. Pref. ...	112—117	...	...
106,000	,,	June 8	6½	6½	Do. 6½ p.c. Red. Deb. ...	98—101	...	...
94,000	,,	,,	§35/-	3½	Do. 3½ p.c. Red. Deb. ...	95—100	...	...
1,076,490	,,	Aug. 10	6⅝	6⅝	Tottenham and District Ord.	152—157	...	...
409,835	,,	,,	5½	5½	Do. 5½ p.c. Pref....	130—135	...	...
62,235	,,	,,	5	5	Do. 5 p.c. Pref. ...	120—125	...	...
371,850	,,	June 8	4	4	Do. 4 p.c. Deb. ...	103—108	...	...
369,774	,,	Aug. 10	7	7	Uxbridge, &c., 5 p.c. ...	165—170	−2½	...
108,330	,,	,,	5	5	Do. 5 p.c. Pref. ...	120—125	...	...
1,340,521	,,	Aug. 10	7	7	Wandsworth Consolidated ...	159—164	...	158—164
1,371,373	,,	,,	5	5	Do. 5 p.c. Pref. ...	122—127	...	125—125½
500,000	,,	,,	...	...	Do. 4 p.c. Pref. ...	104½—107½	...	—
1,317,964	,,	June 8	5	5	Do. 5 p.c. Deb. ...	127—132	...	130
338,300	,,	,,	4	4	Do. 4 p.c. Deb.	103—108	...	...
499,735	,,	Aug. 10	7½	7	Watford and St. Albans Ord.	157—162	...	...
200,000	,,	,,	5	5	Do. 5 p.c. Pref. ...	120—125	...	...
200,000	,,	,,	5½	5½	Do. 5½ p.c. Pref. ...	131—136	...	...
200,000	,,	June 22	4	4	Do. 4 p.c. Red. Deb.	100—105	...	...
100,000	,,	,,	...	3½	Do. 3½ p.c. Red. Deb.	99—102	...	...
158,400	,,	Aug. 24	6b	5½	Winchester W. & G. 5 p.c. Con.	120—125	...	...

a.—The quotation is per £1 of Stock. b.—Paid £3, including 10s. on account of back dividends. * Ex div. † Paid free of income-tax. ‡ For year. § Actual.

Stock and Share List continued overleaf.

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Stocks Officially Quoted on Provincial Exchanges

Issue. £	Stock or Share	When ex-Dividend.	Dividends. Prev. Hf. Yr. % p.a.	Dividends. Last Hf. Yr. % p.a.	NAME.	Quotations. Nov. 27.	Rise or Fall on Week.	Transactions, Lowest and Highest During the Week.
BRISTOL EXCHANGE.								
347,736	Stk.	July 20	6	5	Bath Cons.	122½—124½	...	...
1,647,250	,,	July 6	5	5	Bristol, 5 p.c. max.	118—120	−2	...
120,420	,,	June 8	4	4	Do. 1st 4 p.c. Deb. ...	103—105	...	...
217,870	,,	,,	4	4	Do. 2nd 4 p.c. Deb. ...	103—105	...	...
328,790	,,	,,	5	5	Do. 5 p.c. Deb.	124—127	...	...
274,000	,,	Aug. 10	5	5	Newport (Mon.) 5 p.c. max....	110—114	...	...
13,200	£2	Sept. 7	8⅓	7	Pontyp'l Gas & W. 10 p.c. 'A.'	13½—14½	...	...
13,600	10	,,	6	5	Do. 7 p.c. B.'	12—12½	...	...
40,000	10	,,	6	5	Do. 7 p.c.' C.'	12—12½	...	...
140,778	Stk.	Aug. 10	5	5	Weston-super-Mare Cons. ...	112—114	...	...
64,338	,,	June 22	4	4	Do. 4 p.c. Deb.	100—102	...	...
33,340	,,	,,	7½	7½	Do. 7½ p.c. Deb.	163—166	...	...
LIVERPOOL EXCHANGE.								
137,150	Stk.	Aug. 10	6½	5	Chester 5 p.c. Ord.	107—112	...	...
92,500	,,	June 8	4	4	Do. 4 p.c. Pref.	98—102	...	...
32,540	,,	,,	3	3½	Do. 3½ p.c. Deb. ...	90—95	...	...
41,890	,,	,,	4	4	Do. 4 p.c. Red. Deb. ...	99—103	...	...
2,167,410	,,	Aug. 24	6	6	Liverpool 5 p.c. Ord. ...	135—137	...	...
245,800	,,	June 22	5	5	Do. 5 p.c. Red. Pref ...	103—108	...	...
306,083	,,	July 6	5	5	Do. 4 p.c. Deb. ...	104—106	...	...
106,280	,,	July 20	10	10	Preston 'A' 10 p.c. ...	198—208	...	...
185,219	,,	,,	7	7	Do. 'B' 7 p.c.	137—147	...	...
NEWCASTLE EXCHANGE.								
122,877	Stk.	Aug. 10	8	8	Blyth 5 p.c. Ord.	153—155	...	...
732,000	,,	Aug. 10	5	5	Hartlepool G. & W. Co. & New	125—127	+1	...
2,061,315	,,	Aug. 10	5½	5	Newcastle & Gateshead Con.	28 —28 6a	...	...
682,856	,,	,,	4	4	Do. 4 p.c. Pref. ...	104—106	+1	...
776,704	,,	June 22	3½	3½	Do. 3½ p.c. Deb. ...	100—102	...	...
277,285	,,	May 4	5	5	Do. 5 p.c. Deb. '43...	108—109	...	...
209,820	,,	Aug. 10	8½	8½	South Shields Con.	172—174	...	...
299,542	,,	Aug. 10	6	6	Sunderland 6 p.c. max.	132—134	...	...
NOTTINGHAM EXCHANGE.								
542,270	Stk.	Aug. 10	10	7	Derby Con.	185—195	...	...
35,000	,,	June 22	4	4	Do. 4 p.c. Deb.	100—105	...	...
84,750	,,	Feb. 17	5	12	Long Eaton 'A' Ord. ...	...	...	...
50,000	,,	,,	4	10	Do. 'B' Ord. ...	...	...	...
20,000	10	June 8	5	5	Do. 5 p.c. Pref. ...	10—12	...	...
80,000	Stk.	,,	5	5	Do. 5 p.c. Deb. ...	117—122	...	...
SHEFFIELD EXCHANGE.								
10,000	Stk.	Aug. 10	10	10	Great Grimsby 'A' Ord. ...	220—230	...	...
6,500	,,	,,	10	10	Do. 'B' Ord. ...	220—230	...	...
79,008	,,	,,	10	10	Do. 'C' Ord. ...	205—215	...	...
1,806,339	,,	Aug. 24	6	6	Sheffield Cons.	146—148	...	...
95,000	,,	July 6	4	4	Do. 4 p.c. Deb.... ...	102—105	...	...

a The quotation is per £1 of Stock.

Supplementary List of Stocks and Shares not Officially Quoted

202,152	Stk.	Nov. 2	5	25/-a	Ascot Ord.	118—123	...	...
128,182	,,	July 6	...	5	Do. 5 p.c. Pref.	15—120	...	...
238,631	1	Nov. 16	5	5	Assd. Gas and Water Ord....	20/6—22 6*	...	...
323,681	1	,,	4½	4½	Do. 4½ p.c. Cum. Pref. ...	21/—23/-*	...	...
150,000	Stk.	Sept. 21	...	3½	Do. 3½ p.c. Red. Deb. ...	98—101	...	...
17,000	,,	Aug. 24	8	8	Bognor Orig. Ord. 'A' ...	175—185	...	...
62,210	,,	,,	8	8	Do. New Addl. 'A' ...	175—185	...	...
87,160	,,	,,	7	7	Do. New 7 p.c. max. ...	145—150	...	...
37,440	,,	Aug. 10	10	10	Cam.Univ. & Town 10 p.c.max.	205—215	...	...
125,970	,,	,,	7	7	Do. 7 p.c. max.	155—160	...	...
39,025	,,	,,	5	5	Do. 5 p.c. max.	108—113	...	...
65,000	,,	Aug. 10	8½	7½	Eastbourne 'A' 5 p.c. ...	175—180	...	...
198,000	,,	,,	7	6	Do. 'B' 3½ p.c.	142—147	...	...
112,312	,,	,,	5	5	Do. 5 p.c. Pref.	118—123	...	...
130,000	,,	June 22	5	5	Do. 5 p.c. Deb.	124—129	...	...
24,000	30	Aug. 10	8½	8½	Great Yarmouth 8½ p.c. max.	51—56	...	...
59,400	30	,,	7½	7½	Do. 7½ p.c. max.... ...	42—45	...	...
51,160	Stk.	June 8	5½	5½	Do. 5½ p.c. Deb.... ...	123—128	...	...
152,600	,,	Sept. 7	8	8	Guildford Cons.	182—192	...	...
54,055	,,	,,	5	5	Do. 5 p.c. Pref.	114—119	...	...
68,250	,,	June 8	5	5	Do. 5 p.c. Deb.	120—125	...	...
156,600	,,	Aug. 24	7½	7½	Hampton Court Cons. ...	173—178	...	...
107,960	10	Oct. 5	5½	4	Mid Kent Ord.	10—11	...	...
230,940	Stk.	Aug. 10	10	10	Oxford & District Ord. ...	210—220	...	...
47,112	,,	,,	5	5	Do. 5 p.c. Pref.	118—123	...	...
50,000	,,	,,	6	6	Do. 6 p.c. Red. Pre ...	113—118	...	...
126,193	,,	Nov. 16	7½	7½	Peterborough Ord.	162—172*	...	...
64,990	,,	Sept. 7	6½	7½	Redditch Ord.	133—143	...	...
166,850	,,	Aug. 10	9	8	Romford Ord.	168—178	...	...
60,000	,,	,,	4	4	Do. 4 p.c. Pref.	97—100	...	...
44,000	,,	Sept. 21	5	5	Do. 5 p.c. Deb.	120—125	...	...
10,950	,,	Aug. 24	8	8	Ryde Ord.	165—170	...	...
136,191	,,	Aug. 10	7	5	Scarborough Ord.	126—136	...	...
27,825	,,	Aug. 24	8	8	Shanklin & Ventnor Cons. ...	180—190	...	180
40,643	,,	Sept. 21	7	7	Slough Ord.	156—161	...	...
221,000	,,	June 22	5	5	Do. 5 p.c. Deb.	116—121	...	...
28,872	1	Nov. 2	5½	5½	S. Midland Gas Con.Ltd. Ord.	22/—24/-	...	...
28,866	1	Sept. 7	4½	4½	Do. 4½ p.c. Red. Cum Pref.	22/—24/-	...	...
137,730	Stk.	Aug. 10	7	7	Southgate & Dist. 7 p.c. max.	151—156	...	...
62,500	,,	,,	5	5	Do. 5 p.c. Pref.	120—125	...	...
117,228	,,	Aug. 10	6	5	Swindon Cons.	110—115	...	...
60,425	,,	June 22	5	5	Do. 5 p.c. Deb.	120—125	...	...
64,380	,,	June 8	5	5	Torquay and Paignton 5 p.c. Pf.	117—122	...	...
750,000	1	Oct. 5	5·52d.a	4	Utd. Kingdom Gas Con. Ord.	21/6—22.6	...	21/10½—22/3
468,574	1	,,	2½	2½	Do. 4½ p.c. Preld. Ord....	20/—22/-	...	20/6—21/6
935,902	1	Nov. 16	4½	4½	Do. 4½ p.c. Cum. Pref. ...	22/6—23 6*	...	22/9—23/3
600,000	Srk.	Sept. 21	3½	3½	Do. 3½ p.c. Red. Deb. ...	99—102	...	...
130,000	,,	Aug. 10	8	5	Wakefield Ord.	140—145	...	140
81,650	,,	,,	5	5	Do. 5 p.c. max.	105—110	...	...
82,000	,,	July 20	6	6	Weymouth Ord.	105—110	...	...
98,384	,,	Aug. 10	6	6	Wolverhampton 6 p.c. Pref.	127—132	...	...
160,000	,,	June 8	5½	5½	Do. 5½ p.c. Rd. Db	107—112	...	...
370,000	,,	July 20	6	4	York Cons.	118—123	+7	113
90,000	,,	June 22	5	5	Do. 5 p.c. Red. Deb. ...	110—115	+3	...
133,640	,,	July 20	6½	6½	Yorktown (Cam.) 5 p.c. Cons.	150—160	...	...
120,000	,,	,,	5	5	Do. 5 p.c. Pref.	123—128	...	...
35,000	,,	June 22	5½	5½	Do. 5½ p.c. Deb.... ...	130—135	...	...

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